

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
13 September 2001 (13.09.2001)

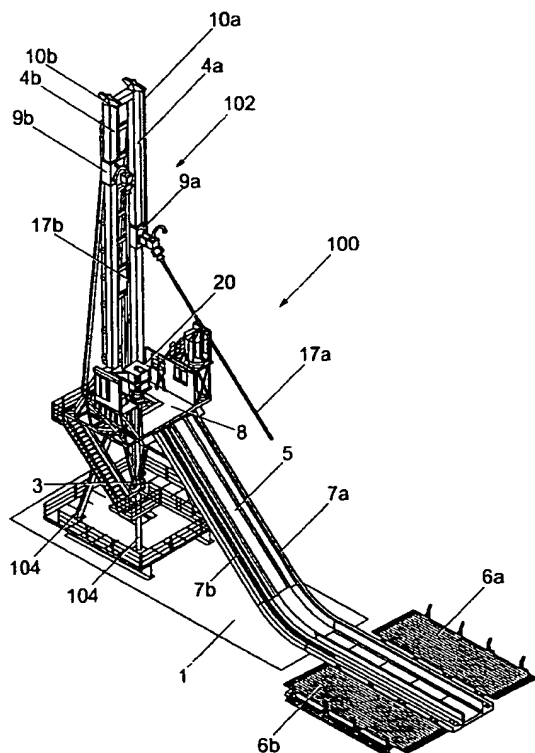
PCT

(10) International Publication Number
WO 01/66905 A2

- (51) International Patent Classification⁷: **E21B 19/16**, 3/04, 19/20, 19/15, 19/10, 21/00, 21/10
- (74) Agent: **MURGITROYD & COMPANY**; 373 Scotland Street, Glasgow G5 8QA (GB).
- (21) International Application Number: **PCT/GB01/00781**
- (22) International Filing Date: 26 February 2001 (26.02.2001)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
0004354.7 25 February 2000 (25.02.2000) GB
- (71) Applicant (for all designated States except US): **WELLSERV PLC** [GB/GB]; HWU Department, Orwell House, Souterhead Road, Aberdeen AB12 3LF (GB).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **ROBICHAUX, Dicky** [US/GB]; The Tower, Melville Court, 75 Rose Street, Aberdeen AB10 1UH (GB).
- (81) Designated States (*national*): AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:
— without international search report and to be republished upon receipt of that report

[Continued on next page]

(54) Title: APPARATUS AND METHOD



(57) Abstract: A tong system includes an upper tong having grips for gripping a tubular and a rotation mechanism to rotate the grips and the tubular. A lower tong also has grips and a rotation mechanism to rotate the grips to provide rotation to a lower tubular, such that the upper and lower tubulars may be made up/broken out from one another, also so that string of tubulars may be rotated for drilling purposes without requiring a rotary table. Also, an apparatus and method for circulating fluid through a tubular string has a first fluid conduit for supplying fluid to the bore of an upper tubular to be made up into or broken out from the tubular string and a second fluid conduit for supplying fluid to the bore of the tubular string, which allows continuous circulation of fluid to occur whilst running the string into/pulling the string from, a borehole and also whilst making up tubulars into/breaking out tubulars from the string. Also, an upper seal for sealing about a portion of the outer circumference of a tubular to be made up onto or broken out from the string and a lower seal means for sealing about a portion of the outer circumference of the string, where the upper seal is an elastomeric ring which has an inner diameter substantially the same as the outer diameter of the tubular. Also, a valve mechanism includes a rotatable plate member and at least one bore. The plate member is moveable between obturation and non-obturation of the tubular. Also, a safety slip to prevent at least one tubular slipping therein has first and second arrangements of grips which are coupled to one another, preferably by a biasing mechanism.

WO 01/66905 A2

BEST AVAILABLE COPY



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

1 "Apparatus and Method"

2

3 The present invention relates to an apparatus and
4 method of drilling boreholes in the ground or subsea
5 surface, and also to an apparatus and method for use
6 in workovers, well maintenance and well
7 intervention, and particularly, but not exclusively
8 relates to apparatus and method for use in
9 hydrocarbon exploration, exploitation and
10 production, but could also relate to other uses such
11 as water exploration, exploitation and production.

12

13 Conventional drilling operations for hydrocarbon
14 exploration, exploitation and production utilise
15 many lengths of individual tubulars which are made
16 up into a string, where the tubulars are connected
17 to one another by means of screw threaded couplings
18 provided at each end. Various operations require
19 strings of different tubulars, such as drill pipe,
20 casing and production tubing.

21

1 The individual tubular sections are made up into the
2 required string which is inserted into the ground by
3 a make up/break out unit, where the next tubular to
4 be included in the string is lifted into place just
5 above the make up/break out unit. A first
6 conventional method of doing this uses a single
7 joint elevator system which attaches or clamps onto
8 the outside surface of one tubular section and which
9 then lifts this upwards. A second conventional
10 method for doing this utilises a lift nubbin which
11 comprises a screw thread which engages with the box
12 end of the tubular such as drill pipe, and the lift
13 nubbin and tubular are lifted upwards by a cable.
14 However, this second method in particular can be
15 relatively dangerous since the lift nubbin and
16 tubular will tend to sway uncontrollably as they are
17 being pulled upwards by the cable.

18

19 From a second aspect, conventional drilling rigs
20 utilise a make up/break out system to
21 couple/decouple the tubular pipe sections from the
22 tubular string. A conventional make up/break out
23 system comprises a lower set of tongs which are
24 brought together to grip the lower pipe like a vice,
25 and an upper set of tongs which firstly grip and
26 then secondly rotate the upper pipe relative to the
27 lower pipe and hence screw the two pipes together.
28 In addition to this conventional make up/break out
29 system, a conventional drilling rig utilises a
30 rotary unit to provide rotation to the drill string
31 to facilitate drilling of the borehole, where the
32 conventional rotary unit is either a rotary table

1 provided on the drill rig floor or a top drive unit
2 which is located within the drilling rig derrick.

3

4 According to a first aspect of the present invention
5 there is provided an apparatus for handling
6 tubulars, the apparatus comprising a pair of
7 substantially vertical tracks;
8 a rail mechanism movably connected to each track;
9 and

10 a coupling mechanism, associated with the rail
11 mechanism, for coupling to a tubular; and
12 a movement mechanism to provide movement to the rail
13 mechanism.

14

15 According to a second aspect of the present
16 invention there is provided a method of handling
17 tubulars, the method comprising:-
18 providing a rail mechanism, the rail mechanism being
19 associated with a coupling mechanism for coupling to
20 a tubular, and the rail mechanism being movably
21 connected to a substantially vertical track;
22 coupling the coupling mechanism to a tubular; and
23 operating a movement mechanism to move the rail
24 mechanism.

25

26 The substantially vertical tracks are preferably
27 secured to a frame which is typically a derrick of a
28 drilling rig. The pair of substantially vertical
29 tracks are preferably arranged about the
30 longitudinal axis of a borehole mouth, such that the
31 pair of tracks and the borehole mouth lie on a

1 common plane, with one track at either side of the
2 borehole mouth.

3
4 Preferably, the rail mechanism is suitably connected
5 to the respective track by any suitable means such
6 as runners or rollers and the like.

7 The movement mechanism may comprise a motive means
8 associated with the runners or rollers and the like.
9 Alternatively, the movement mechanism may comprise a
10 cable, winch or the like coupled at one end to the
11 rail mechanism and coupled at the other end to a
12 motor and reel arrangement or a suitable
13 counterweight arrangement or a suitable
14 counterbalance winch hoisting or the like.

15
16 Preferably, the coupling mechanism comprises a
17 suitable coupling for coupling to the tubular, where
18 the suitable coupling may comprise a member provided
19 with a screw thread thereon for screw threaded
20 engagement with one end of the tubular.

21 Alternatively, the suitable coupling may comprise a
22 vice means to grip the end of the tubular.

23 Alternatively, the suitable coupling may comprise a
24 fluid swivel which couples directly to the end of
25 the tubular, or indirectly to the end of the tubular
26 via a kelly. Typically, the derrick may be provided
27 with a tubular rack for storing tubulars, and a ramp
28 which may extend downwardly at an angle from the
29 lower end of the derrick toward the tubular rack,
30 and a tubular guide track may also be provided at
31 one or both sides of the ramp.

32

1 According to a third aspect of the present invention
2 there is provided an apparatus for handling a
3 tubular, the apparatus comprising at least one
4 substantially vertical track;
5 a coupling mechanism, connected to the track, for
6 coupling to a tubular;
7 a pair of moveable members which are hingedly
8 connected to both the coupling mechanism and the
9 vertical track, such that movement of the pair of
10 moveable members results in movement of the coupling
11 mechanism substantially about a longitudinal axis of
12 the track.

13

14 According to a fourth aspect of the present
15 invention there is provided a method of handling a
16 tubular, the method comprising providing at least
17 one substantially vertical track;
18 connecting a coupling mechanism to the track, the
19 coupling mechanism for coupling to a tubular;
20 providing a pair of moveable members which are
21 hingedly connected to both the coupling mechanism
22 and the vertical track; and
23 moving the pair of moveable members to move the
24 coupling mechanism substantially about a
25 longitudinal axis of the track.

26

27 Preferably, a rail mechanism is provided and which
28 is movably connected to the track, and typically,
29 the coupling mechanism is associated with the rail
30 mechanism. More preferably, the pair of movable
31 members are hingedly connected to both the coupling
32 mechanism and the rail mechanism.

1
2 Preferably, there are a pair of substantially
3 vertical tracks, and the substantially vertical
4 tracks are preferably secured to a frame which is
5 typically a derrick of a drilling rig. The pair of
6 substantially vertical tracks are preferably
7 arranged about the longitudinal axis of a borehole
8 mouth, such that the pair of tracks and the borehole
9 mouth lie on a common plane, with one track at
10 either side of the borehole mouth. Typically, the
11 movement of the pair of movable members results in
12 movement of the coupling mechanism substantially
13 about the longitudinal axis of the track such that a
14 longitudinal axis of a tubular coupled to the
15 coupling mechanism is substantially coincident with
16 the longitudinal axis of the borehole mouth.

17
18 Preferably, a motive means is provided to permit
19 movement of the pair of moveable members, where the
20 motive means may be a suitable motor such as a
21 hydraulic motor.

22
23 According to a fifth aspect of the present
24 invention, there is provided a tong apparatus, the
25 tong apparatus comprising:-
26 an upper tong having a gripping means for gripping a
27 tubular, the upper tong further comprising a
28 rotation mechanism to provide rotation to the
29 gripping means to provide rotation to said tubular;
30 and
31 a lower tong having a gripping means for gripping a
32 tubular, the lower tong further comprising a

1 rotation mechanism to provide rotation to the
2 gripping means to provide rotation to said tubular.

3

4 According to a sixth aspect of the present
5 invention, there is provided a method of providing
6 rotation to at least one tubular, the method
7 comprising:-

8 providing an upper tong having a gripping means for
9 gripping a tubular, the upper tong further
10 comprising a rotation mechanism to provide rotation
11 to the gripping means;
12 providing a lower tong having a gripping means for
13 gripping a tubular, the lower tong further
14 comprising a rotation mechanism to provide rotation
15 to the gripping means; and
16 operating at least the rotation mechanism of the
17 upper tong to provide rotation to said tubular.

18

19 Preferably, the method further comprises operating
20 the rotation mechanism of the lower tong to provide
21 rotation to said tubular.

22

23 Typically, the upper tong comprises a plurality of
24 gripping means. Preferably, a range of gripping
25 means can be utilised to grip differing diameters of
26 tubulars.

27

28 Preferably, a motive means is provided to actuate
29 the rotation mechanism, where the motive means may
30 be a hydraulic motor having a suitable hydraulic
31 fluid power supply.

32

1 Preferably, the lower tong comprises a plurality of
2 gripping means. Preferably, a range of gripping
3 means can be utilised to grip differing diameters of
4 tubulars. Preferably, a motive means is provided to
5 actuate the rotation mechanism, where the motive
6 means may be a hydraulic motor having a suitable
7 hydraulic fluid power supply. Preferably, the lower
8 tong further comprises a turntable bearing means
9 which support ring gear of the gripping means.
10 Typically, the lower tong further comprises a
11 breaking system which permits controlled release of
12 residual tubular string torque.

13

14 Preferably, a travelling slip mechanism is also
15 provided and which is capable of engaging at least a
16 portion of the outer circumference of a tubular
17 string, and preferably, the travelling slip is
18 capable of being rotated with respect to the derrick
19 by means of a rotary bearing assembly mechanism.
20 Typically, the travelling slip is provided with a
21 vertical movement mechanism which can be actuated to
22 move the travelling slip and the engaged tubular
23 string in one or both vertical directions.

24

25 According to a seventh aspect of the present
26 invention, there is provided an apparatus for
27 circulating fluid through a tubular string, the
28 string comprising at least one tubular, the
29 apparatus comprising:-
30 a first fluid conduit for supplying fluid to the
31 bore of an upper tubular to be made up into or
32 broken out from the tubular string; and

1 a second fluid conduit for supplying fluid to the
2 bore of the tubular string.

3

4 According to an eighth aspect of the present
5 invention, there is provided a method of circulating
6 fluid through a tubular string, the string
7 comprising at least one tubular, the method
8 comprising:-

9 providing a first fluid conduit for supplying fluid
10 to the bore of an upper tubular to be made up into
11 or broken out from the tubular string; and
12 providing a second fluid conduit for supplying fluid
13 to the bore of the tubular string.

14

15 Preferably, the first fluid conduit is releasably
16 engageable with an upper end of the upper tubular.
17 Preferably, the first fluid conduit is provided with
18 a valve mechanism which can be operated to permit
19 the flow of fluid into or deny the flow of fluid
20 into the first fluid conduit and/or upper end of the
21 tubular.

22

23 Preferably, one end of the second fluid conduit is
24 in fluid communication with a chamber, and
25 typically, the second fluid conduit is provided with
26 a valve mechanism which can be operated to permit
27 the flow of fluid into, or deny the flow of fluid
28 into, the second fluid conduit and/or the chamber.

29

30 Preferably, the chamber is adapted to permit a
31 tubular to be made up into, or broken out from, a
32 tubular string. The chamber typically comprises a

1 bore, which is preferably arranged to be
2 substantially vertical, and is more preferably
3 arranged to be coincident with the longitudinal axis
4 of the mouth of the borehole. Typically, the
5 chamber comprises an upper port into which the said
6 tubular can be inserted into or removed from the
7 chamber. Preferably, a valve mechanism is provided
8 and is actuatable to seal the bore of the chamber,
9 typically at a location below the upper port.
10 Preferably, an upper seal is provided, where the
11 upper seal is preferably located above the said
12 location, and where the upper seal is arranged to
13 seal around at least a portion of the circumference
14 of the said tubular. Typically, a lower seal is
15 provided, where the lower seal is preferably located
16 below the said location, and where the lower seal is
17 arranged to seal around at least a portion of the
18 circumference of the tubular string.
19
20 Preferably, a valve system comprising one or more
21 further valves is provided to control the supply of
22 fluid to the first fluid conduit valve mechanism and
23 second fluid conduit mechanism.
24
25 Typically, the method comprises the further steps of
26 inserting the lower end of the upper tubular into
27 the upper port, where the valve mechanism typically
28 denies the flow of fluid into the first fluid
29 conduit. At this point, the valve mechanism seals
30 the bore of the chamber. Thereafter, the upper seal
31 seals around at least a portion of the circumference
32 of the tubular, and the valve mechanism of the

1 second fluid conduit is operated to permit the flow
2 of fluid into the chamber, preferably at a location
3 below the valve mechanism sealing the bore of the
4 chamber, such that fluid flows into the upper end of
5 the tubular string.

6
7 The method preferably comprises the further steps of
8 operating the valve mechanism to permit the flow of
9 fluid into the first fluid conduit and upper end of
10 the tubular. Preferably, thereafter, the valve
11 mechanism is actuated to open the bore of the
12 chamber, and thereafter, the valve mechanism is
13 operated to deny the flow of fluid into the second
14 fluid conduit. Thereafter, the tubular is
15 preferably made up into the tubular string, and
16 thereafter, the first fluid conduit is typically
17 released from engagement with the upper end of the
18 upper tubular.

19
20 According to a ninth aspect of the present
21 invention, there is provided an apparatus for
22 providing a seal between a tubular to be made up in
23 to or broken out from a tubular string, the tubular
24 string comprising at least one tubular, the
25 apparatus comprising:-

26 an upper seal means for sealing about a portion of
27 the outer circumference of the said tubular to be
28 made up onto or broken out from the string;
29 a lower seal means for sealing about a portion of the
30 outer circumference of the string; and
31 the upper seal comprising an elastomeric ring which
32 is adapted to have an inner diameter substantially

1 the same as the outer diameter of at least a portion
2 of the tubular.

3
4 Preferably, the elastomeric ring is formed from a
5 suitable material such as rubber. Typically, the
6 lower seal also comprises an elastomeric ring which
7 is adapted to have an inner diameter substantially
8 the same as the outer diameter of at least a portion
9 of tubular string.

10

11 According to a tenth aspect of the present invention
12 there is provided a valve mechanism for use in
13 providing a seal between two tubulars, the valve
14 mechanism comprising:-

15 a plate member which is capable of rotation about an
16 axis;

17 at least one bore formed through the plate member;
18 the plate member being arranged such that it is
19 capable of movement between a first configuration in
20 which a portion of the plate member obturates the
21 longitudinal axis of at least one of the tubulars;
22 and

23 a second configuration in which the bore is
24 concentric with the longitudinal axis of at least
25 one of the tubulars.

26

27 According to an eleventh aspect of the present
28 invention there is provided a method of providing a
29 seal between two tubulars, the method comprising:-
30 providing a plate member which is capable of
31 rotation about an axis;
32 the plate member having at least one bore;

1 wherein the plate member is capable of being rotated
2 between a first configuration in which a portion of
3 the plate member obturates the longitudinal axis of
4 at least one of the tubulars; and
5 a second configuration in which the bore is
6 concentric with the longitudinal axis of at least
7 one of the tubulars.

8

9 Preferably, the plate member is capable of being
10 rotated between a first configuration from which a
11 portion of the plate member obturates the
12 longitudinal axis of both of the tubulars, and a
13 second configuration in which the bore is concentric
14 with the longitudinal axis of both of the tubulars,
15 both of the tubulars being concentric with one
16 another.

17

18 Preferably, the plate member is arranged within a
19 chamber, such that the radius of the plate member is
20 perpendicular to the longitudinal axis of both
21 tubulars. Preferably, the plate member is
22 substantially circular, and more preferably, the
23 centre axis of the plate member is off-centre with
24 respect to the longitudinal axis of both tubulars.

25

26 According to a twelfth aspect of the present
27 invention, there is provided an apparatus to prevent
28 a tubular slipping therein, the apparatus comprising
29 a first arrangement of grips adapted to grip the
30 tubular, and a second arrangement of grips adapted
31 to grip the tubular, characterised in that the first

1 and second arrangements of grips are coupled to one
2 another.
3
4 Preferably the first and second arrangements of
5 grips are coupled to one another by a coupling
6 mechanism which is more preferably a biasing
7 mechanism. Preferably the biasing mechanism is
8 arranged to bias the first and second arrangements
9 of grips away from one another. Preferably at least
10 one of or more preferably both of each of the first
11 and second arrangements of grips comprise a first
12 and second portions wherein the first portion is
13 coupled to the second portion by a tapered surface
14 and preferably a moveable locking mechanism, such
15 that the first portion is capable of moving with
16 respect to the second portion along the tapered
17 surface.
18
19 Preferably the first arrangements of grips are
20 located vertically below the second arrangements of
21 grips and the first arrangements of grips comprise a
22 relatively large surface area for gripping the
23 tubular and are the primary gripping arrangement.
24
25 Typically the second arrangement of grips comprise a
26 relatively smaller surface area for gripping the
27 tubular and provide a backup or safety gripping
28 arrangement.
29
30 Preferably a lower face of the second arrangement of
31 grips is coupled to an upper face of the first
32 arrangement of grips and the upper face of the first

1 arrangement of grips is of a larger surface area
2 than a lower face of the first arrangement of grips.

3

4 Preferably the first arrangement of grips comprise a
5 stop means for preventing movement of the second
6 arrangement of grips in a direction, preferably
7 radially, away from the tubular being gripped.

8

9 Embodiments of the invention will now be described,
10 by way of example only, with reference to the
11 accompanying drawings, in which:-

12

13 Fig. 1 is a perspective view of a drilling rig
14 incorporating aspects of the present invention;
15 Fig. 2 is a portion of the drilling rig of Fig.
16 1 in a first configuration;

17 Fig. 3a is a portion of the drilling rig of
18 Fig. 1 in a second configuration;

19 Fig. 3b is a more detailed perspective view of
20 the portion of the drilling rig of Fig. 3a;

21 Fig. 4 is a front perspective view of a portion
22 of the drilling rig of Fig. 3a;

23 Fig. 5 is a perspective view looking upwardly
24 at the portion of the drilling rig of Fig. 3a;

25 Fig. 6 is a perspective view of a ramp and
26 drill pipe loading area of the drilling rig of
27 Fig. 1;

28 Fig. 7a is a cross-sectional side view of the
29 derrick of the drilling rig of Fig. 1;

30 Fig. 7b is a front view of the derrick of Fig.
31 7a;

1 Fig. 8a is a cross-sectional more detailed view
2 of a portion of the apparatus of Fig. 8b;
3 Fig. 8b is a front cross-sectional view of a
4 portion of the derrick of the drilling rig of
5 Fig. 1;
6 Fig. 9a is a cross-sectional more detailed view
7 of a portion of the derrick of Fig. 9b;
8 Fig. 9b is a front cross-sectional view of the
9 derrick of the drilling rig of Fig. 1;
10 Fig. 10a is a more detailed view of a portion
11 of the apparatus of Fig. 10b;
12 Fig. 10b is a front view of the derrick of Fig.
13 1;
14 Fig. 11a is a more detailed view of a portion
15 of the apparatus of Fig. 11b;
16 Fig. 11b is a front view of the derrick of Fig.
17 1;
18 Fig. 12a is a side view of the derrick of Fig.
19 1;
20 Fig. 12b is a front view of the derrick of Fig.
21 1;
22 Fig. 13a is a side view of the derrick of Fig.
23 1;
24 Fig. 13b is a front view of the derrick of Fig.
25 1;
26 Fig. 14a is a more detailed view of the portion
27 of the apparatus of Fig. 14b;
28 Fig. 14b is a front view of the derrick of Fig.
29 1;
30 Fig. 15a is a side view of the derrick of Fig.
31 1;

1 Fig. 15b is a front view of the derrick of Fig.
2 1;
3 Fig. 16a is a side view of the derrick of Fig.
4 1;
5 Fig. 16b is a front view of the derrick of Fig.
6 1;
7 Fig. 17a is a front view of upper and lower
8 tongs mounted within a snubbing unit;
9 Fig. 17b is a perspective view of a portion of
10 the snubbing unit of Fig. 17a;
11 Fig. 17c is a top view of a portion of the
12 snubbing unit of Fig. 17a;
13 Fig. 17d is a rear view of a portion of the
14 snubbing unit of Fig. 17a;
15 Fig. 17e is a side view of a portion of the
16 snubbing unit of Fig. 17a;
17 Fig. 18 is a more detailed part cross-sectional
18 view of a portion of the snubbing unit of Fig.
19 17a;
20 Fig. 19 is a more detailed part cross-sectional
21 view of the snubbing unit of Fig. 17a;
22 Fig. 20 is a more detailed part cross-sectional
23 view of a portion of the snubbing unit of Fig.
24 17a;
25 Fig. 21 is a more detailed part cross-sectional
26 view of a portion of the snubbing unit of Fig.
27 17a;
28 Fig. 22 is a more detailed part cross-sectional
29 view of a portion of the snubbing unit of Fig.
30 17a;
31 Fig. 23 is a perspective view of a valve plate
32 of the snubbing unit of Fig. 17a;

1 Fig. 24 is a schematic view of the snubbing
2 unit of Fig. 17a showing a continuous
3 circulation configuration with a main valve
4 closed;
5 Fig. 25 is a schematic view of the snubbing
6 unit of Fig. 17a in a continuous circulation
7 configuration with the main valve open;
8 Fig. 26 is a schematic view of the snubbing
9 unit of Fig. 17a incorporating a stripper
10 design;
11 Fig. 27 is a schematic view of the snubbing
12 unit of Fig. 17a incorporating a ram design in
13 a first configuration;
14 Fig. 28 is a schematic view of the snubbing of
15 Fig. 17a incorporation a ram design in a second
16 configuration;
17 Fig. 29 is a cross-sectional view of a first
18 embodiment of a safety slip mechanism, in
19 accordance with a twelfth aspect of the present
20 invention, in an open configuration;
21 Fig. 30 is a cross-sectional view of the safety
22 slip mechanism of Fig. 29 in a closed
23 configuration;
24 Fig. 31 is a cross-sectional view of a portion
25 of the safety slip mechanism of Fig. 29;
26 Fig. 32 is a half cross sectioned view of a
27 second embodiment of a safety slip mechanism,
28 in accordance with the twelfth aspect of the
29 present invention, in a closed configuration;
30 Fig. 33 is a cross-sectional view of the second
31 embodiment of the safety slip mechanism of Fig.
32 32, but in an open configuration; and

1 Fig. 34 is a cross-sectional plan view of the
2 safety slip mechanism of Fig. 33 through
3 section C-C.

4
5 Fig. 1 shows a drilling rig generally designated at
6 100. The drilling rig 100 is particularly suited
7 for use in the business of exploration, exploitation
8 and production of hydrocarbons, but could also be
9 used for the same purposes for other gases and
10 fluids such as water. With regard to hydrocarbons,
11 the drilling rig 100 can be used for operations such
12 as, but not limited to, snubbing, side tracks, under
13 balanced drilling, work overs and plug and
14 abandonments. The drilling rig 100 can be utilised
15 for land operations (as shown in Fig. 1) as well as
16 in marine operations since it can be modified to be
17 installed on an offshore drilling rig, a drill ship
18 or other floating vessels.

19
20 The drilling rig 100 comprises a derrick 102 which
21 extends vertically upwardly from a rig floor 8,
22 where the rig floor 8 is carried by a suitable
23 arrangement of supports 104 which are secured by
24 appropriate means to the ground 1 or floating vessel
25 top side 1.

26
27 As can be seen in Figs. 1 to 4 and 6, the drilling
28 rig 100 optionally includes a ramp 5 which extends
29 downwardly at an angle from the rig floor 8. The
30 ramp 5 can be used by personnel as an evacuation
31 slide 5 if it is required that the personnel quickly
32 evacuate the drilling rig 100. A drill pipe guide

1 track 7a, 7b is located at each side of the slide 5
2 and which fully extends from the drill rig floor 8
3 to the ground 1. A drill pipe rack 6a, 6b is
4 located at the outer side of each respective drill
5 pipe guide track 7a, 7b, where the rack 6a, 6b is
6 capable of holding a plurality of tubular drill pipe
7 lengths, such as drill pipe 17. Each rack 6a, 6b
8 comprises two or more kickover troughs (not shown)
9 spaced along the length of the rack 6a, 6b, where
10 the troughs can be operated to move lengths of drill
11 pipe 17 from the rack 6a, 6b to the respective track
12 7a, 7b or vice versa as required, and do this by
13 being angled either respectively inwardly or
14 outwardly by approximately two or three degrees
15 either way. A rope or counterbalance winch
16 arrangement (not shown) is also provided for each
17 pipe guide track 7, such that the rope/winch
18 arrangement can be operated to pull pipes 17 from
19 the lower end of the track 7a, 7b up to the drill
20 rig floor 8. The rope/winch arrangement can also be
21 operated to lower pipe 17 from the drill rig floor 8
22 to the lower end of the track 7a, 7b.

23

24 It should however be noted that the downwardly
25 angled fire evacuation slide 5 is an optional
26 feature of the drilling rig 100.

27

28 Fig. 1 also shows an arm runner 9a, 9b being
29 moveably located on a respective derrick dolly track
30 4a, 4b. As shown in Figs. 3b, 7a and 8b for
31 example, each arm runner 9a, 9b is provided with a
32 pair of articulated pipe arms 12 which are hingedly

1 attached at one end to the respective arm runner 9a,
2 9b and are hingedly attached at the other end to a
3 respective pipe handler fluid swivel 13a, 13b. This
4 arrangement allows the fluid swivel 13a, 13b to be
5 moved, by means of suitable motors (not shown),
6 inwardly from the plane parallel to the longitudinal
7 axis of the respective dolly track 4a, 4b to the
8 plane parallel with the longitudinal axis of the
9 borehole, such that the articulated pipe arms 12 act
10 like a collapsible parallelogram. A respective
11 goose neck pipe 18a, 18b is provided at the upper
12 end of the respective fluid swivel 13a, 13b and is
13 in sealed fluid communication with the internal bore
14 of the respective fluid swivel 13a, 13b. A suitable
15 pipe end coupling is provided at the lower end of
16 each fluid swivel 13, where this pipe end coupling
17 may suitably be a screw thread coupling for
18 connection with the box end of a drill pipe 17. A
19 wire pulley 10a, 10b is provided for each arm runner
20 9, and is secured at one end to the upper portion of
21 the arm runner 9, where the other end of the wire
22 pulley 10 is coupled to a suitable lifting/lowering
23 mechanism, which may be a motor and reel
24 arrangement, or may be a suitable counter weight
25 arrangement, or may be a suitable counter balance
26 winch hoisting (not shown).

27

28 Alternatively however, the dolly tracks 4A, 4B of
29 the derrick 102 could be modified to be the same as
30 the dolly tracks of a conventional rig in which
31 there will be a block (not shown) and top drive (not
32 shown), and in this case the arm runners 9A, 9B are

1 also suitably modified such that they can be used in
2 conventional dolly tracks of a conventional rig.
3
4 A method of operating the pipe handling mechanism,
5 in accordance with an aspect of the present
6 invention, will now be described. Drill pipe 17a is
7 lifted up one of the guide tracks 7a as previously
8 described, until the upper end of the drill pipe 17a
9 is located in relatively close proximity to the pipe
10 coupling provided on the first pipe handler swivel
11 13a. The box end of the drill pipe 17a is then
12 coupled to the pipe end coupling of the fluid swivel
13 13a, such that the pipe handling mechanism is in the
14 configuration shown in Fig. 2. The cable 10a
15 lifting/lowering mechanism is then operated such
16 that the arm runner 9a, and hence drill pipe 17a is
17 lifted upwardly to the configuration shown in Figs.
18 1, 3a, 3b, 4, 5, 7a and 7b, until the arm runner 9a
19 and hence drill pipe 17a are in the configuration
20 shown in Figs. 8a and 8b. It should be noted that
21 it is preferred that the drill pipe 17a is lifted
22 upwardly at a downwardly projecting angle, and this
23 provides the advantage that the lower end of the
24 drill pipe 17a is kept well clear of the rig floor.
25 8.
26
27 However, it should be noted that the other arm
28 runner 9b and drill pipe 17b have already been moved
29 in a similar manner, and the associated motor has
30 been operated to move the drill pipe 17b such that
31 the articulated pipe arms 12 have moved inward and
32 the drill pipe 17b is co-axial with the borehole.

1

2 A make up/break out unit will now be described for
3 making up the drill string, in accordance with the
4 present invention.

5

6 A make up/break out unit in the form of a snubbing
7 unit is generally designated at 20 and is shown in
8 Fig. 17(a) as comprises a frame 106 which is made up
9 of a work basket base 106a, support column spacers
10 106b, work basket support column 106c, and snubbing
11 unit base 106d. An upper tong 108 and a lower tong
12 109 are mounted within a tong frame 110 which is
13 further mounted within the work basket base 106a as
14 can be seen in Fig. 17a, where the tong frame 110
15 can be seen in isolation in Figs. 17b to 17e.

16

17 It should be noted that the upper tong 108 can be
18 used to make up/break out work strings, casing and
19 production tubulars as large as $8\frac{5}{8}$ inches in
20 diameter, although if modified in a suitable
21 fashion, then it could be used for larger diameters
22 if required.

23

24 The lower tong 109 is also known as a rotary back up
25 109, and is used to rotate the drill string 17 at
26 speed and torque required for milling, side tracking
27 and drilling. However, the lower tong 109 also acts
28 as a back up to the upper tong 108 when making up or
29 breaking out connections.

30

31 Another main component of the snubbing unit 20 is a
32 rotary bearing assembly 112 which is coupled to the

1 upper surface of a cylinder plate 116. The moveable
2 bearing of the rotary bearing 112 is secured to a
3 set of travelling slips 114 which are used to engage
4 the drill pipe 17, and hence the rotary bearing
5 assembly 112 allows the travelling slips 114 to
6 rotate whilst the slips 114, as will subsequently be
7 described, support the weight of the drill string to
8 permit simultaneous vertical pipe manipulation and
9 rotation of the work string. As will also be
10 described, a hydraulic swivel or hydraulic bypass
11 (not shown) is integrated into the rotary bearing
12 assembly 112 and allows the slips 114 to be remotely
13 operated at all times and eliminate the need to
14 make/break hose connections.

15

16 Mounting the tong system above the snubbing unit 20
17 travelling slips 114 eliminates the need to swing
18 tongs 108, 109 to engage and disengage the drill
19 pipe 17 at every drill pipe joint connection by
20 allowing the drill pipe 17 and drill pipe joints to
21 pass through the tongs 108, 109 during tripping
22 operations. The tongs 108, 109 and travelling slips
23 114 have a manually operated "large-bore" feature
24 which allows their bore to be quickly increased to
25 allow passage of downhole tools with diameters up to
26 and over 11 inches. A remotely mounted control
27 panel can be utilised to operate all tong 108, 109
28 functions at any jack position without placing
29 personnel at dangerous positions, and this enhances
30 safety and speeds tripping operations.
31 Additionally, this has the advantage that operators
32 will be able to make up/break out connections while

1 the drill pipe 17 is being moved by the snubbing
2 unit 20. It should be noted that reactive make
3 up/break out torques are transferred between the
4 tongs 108, 109 via the frame 106 and a reaction
5 column 118 (as shown in Fig. 17(a) and 14 (as shown
6 in Fig. 4), which is coupled to the frame 106 by
7 means of a roller joint 120. Hence, the snubbing
8 unit 20 can move vertically upwardly or downwardly
9 by means of the roller joint 120. Hydraulic jacking
10 cylinders 122, of which there are preferably four,
11 are arranged, and act, between the stationary
12 snubbing unit base 106d and the moveable cylinder
13 plate 116, and actuation of the hydraulic jacking
14 cylinders 122 provides movement to the cylinder
15 plate 116 and hence snubbing unit 20.

16

17 Fig. 17a also shows the location of fixed/stationary
18 slips 124 as being mounted to the upper section of
19 the BOP stack 126, where the fixed slips 124 and BOP
20 stack 126 are stationary with respect to the drill
21 rig floor 8. Hence, the snubbing unit 20 is
22 moveable by the hydraulic jacking cylinders 122 with
23 respect to the fixed slips 124.

24

25 The active make up/break out torques are transferred
26 between the upper tong 108 and lower rotary back up
27 109 by means of an integral reaction column in the
28 form of a closed head tong leg assembly 113 and the
29 substructure of the derrick 102. This allows the
30 snubbing unit 20 to accept conventional hydraulic
31 load cell and torque gauge assemblies and/or

1 electronic load cells required for computerised
2 tubular make up control.
3
4 Reactive drilling torques will be transferred back
5 to the derrick 102 by means of the reaction column
6 118 (shown in Fig. 3(b) as being securely mounted to
7 the derrick 102) and roller joint 120. Hence, this
8 rigid mounting system allows high speed work string
9 rotation during milling/drilling operations with a
10 minimum of rotating components, these being the
11 travelling slips 114 and a portion of the rotary
12 bearing assembly 112, which reduces vibration and
13 hazards associated with exposed rotating equipment.
14
15 The upper tong 108 will now be described in detail.
16 The upper tong 108 provides means to make up and
17 break out tubing, casing or drill pipe during
18 tripping and snubbing operations, and is
19 hydraulically powered. The upper tong 108 comprises
20 three sliding jaws (not shown) which virtually
21 encircle the drill pipe 17 to maximise torque while
22 minimising marking and damage to the outer surface
23 of the drill pipe 17. The upper tong 108 is
24 provided with a cam operated jaw system (not shown)
25 which can be opened to allow passage of work string
26 tool joints as well as tubing and casing couplings.
27 A range of jaw systems can be used for different
28 dies such as dove tail strip dies which are used
29 with drill pipe tool joints, and wrap around dies
30 which are used with tubing or casing. The upper
31 tong 108 can also be used for running CRA tubulars
32 (such as 13% to 26% Cr tubulars) with grit faced

1 dies. Additionally, non-marking aluminium dies can
2 also be used with low friction jaws. Additionally,
3 electronic turns encoder(s) and electronic load
4 cell(s) can be provided to permit torque turn
5 compatibility with electronic OCTG analysis systems,
6 which can provide a record, such as a computer print
7 out, of the quality of the make up between the
8 respective end joints of two tubulars.
9 Additionally, it should be noted that the dies can
10 be replaced whilst pipe passes through the upper
11 tong 108. Also, the upper tong 108 can be manually
12 operated such that the tong bore can be increased to
13 allow passage of tools with diameters up to 11.06
14 inches. The upper tong 108 is powered by twin two
15 speed hydraulic motors (not shown) which provide
16 speeds and torque capable of spinning and
17 making/breaking high torque connections. The upper
18 tong 108 is provided with a hydraulic power supply
19 which has a 35 gpm and 3000 psi output (62 hydraulic
20 Horse Power) which produces 30,000 ft lbs at 9 rpm
21 and high torque, low speed mode and 15,000 ft lbs at
22 18 rpm in low torque, high speed mode.
23 Alternatively, the hydraulic motors can provide 24
24 rpm maximum speed and low torque, high speed mode at
25 47.6 gpm which is the maximum allowable flow rate
26 using a standard PVG 120 Danfoss™ valve package,
27 although alternative valve systems can be used to
28 provide even higher speeds at higher flow rates.
29 The upper tong 108 can be used for tubulars with a
30 range from $2^{1/16}$ inches to $8^{5/8}$ inches outside
31 diameter with a range of jaws and dies being
32 supplied as required to accommodate the varying

1 diameters. The gripping range for jaws being
2 supplied with dove tail dies is half an inch under
3 the nominal size of the jaws, and the gripping range
4 for jaws supplied with wrap around dies is that the
5 wrap around dies are machined to match specific
6 tubing, casing, tool joints, couplings or accessory
7 diameters.

8
9 The lower tong or rotary back up 109 has two
10 functions. During drilling operations, the rotary
11 back up 109 generates the torque required for high
12 speed milling and drilling. This torque is
13 transferred to the outer diameter of the work or
14 drill string 17 by means of three sliding jaws.
15 During tripping operations, the jaws of the rotary
16 back up 109 are activated to grip the pipe 17 and
17 resist the torque generated by the upper tong 108
18 when making up or breaking out the tubular
19 connections. However, the rotary back up 109
20 differs from the upper tong 108 in several aspects.
21 Firstly, the rotary back up 109 has large turntable
22 bearings (not shown) to support the ring gear (not
23 shown) instead of a series of dumb bell roller
24 assemblies (not shown) which are provided on the
25 upper tong 108. Also, the body of the rotary back
26 up 109 is sealed and filled with gear oil to protect
27 the bearings in gear surfaces during extended
28 periods of drilling. A hydraulically operated
29 braking system (not shown) is also provided which
30 allows controlled release of residual work string
31 torque. However, the rotary back ups 109 drive
32 train (not shown) is similar to the drive train (not

1 shown) of the upper tong 108, but features different
2 motor displacements and gear ratios. However, like
3 the upper tong 108, the rotary back up 109 utilises
4 three jaws which virtually encircle the pipe 17 to
5 maximise torque whilst minimising marking and damage
6 to the outer surface of the pipe 17. The cam
7 operated jaw system (not shown) of the rotary back
8 up 109 can be opened to allow passage of tubing and
9 casing couplings, and the rotary back UP's 109 jaw
10 systems (not shown) are interchangeable with those
11 of the upper tong 108. Dovetail strip dies (not
12 shown) can be provided for the rotary back up's 109
13 jaws for use with drill pipe tool joints and wrap
14 around dies can be used for tubing or casing.
15 Additionally, the dies can be replaced while the
16 drill pipe 17 passes through the rotary back up 109,
17 and the rotary back up 109 can be manually operated
18 to increase it's bore to allow the passage of tools
19 with diameters up to 11.06 inches. Twin two speed
20 hydraulic motors (not shown) provides speeds for
21 milling and drilling operations. A removable lower
22 pipe guide plate assembly (not shown) is provided
23 separately for each specific coupling diameter and
24 assists pipe alignment during jacking operations.
25
26 The hydraulic power supply of the rotary back up 109
27 supplies 145 gpm and 2250 psi output (190 hydraulic
28 horse power) and produces 7500 ft lbs at 80 rpm in
29 high speed, low torque mode and 15000 ft lbs at 40
30 rpm in high torque, low speed mode.
31

1 The tubular capacity and the gripping range for the
2 rotary back up 109 is the same as that for the upper
3 tong 108.

4
5 Referring again to Fig. 17(a), the tong frame 110 is
6 bolted to the travelling slips 114 via a lower tong
7 frame 111, although it should be noted that some
8 configurations may require a separate adapter plate
9 (not shown). The upper tong 108 is suspended within
10 the tong frame 111 by double acting spring
11 assemblies located on legs 113 (see Fig. 17(b))
12 which extend upward from the rotary back up 109.
13 The upper tong 108 can be pinned in one of two
14 positions to facilitate make up of work string tool
15 joints and connections using couplings. The spring
16 assemblies (not shown) within legs 113 allow the
17 upper tong 108 to float ± 2.5 inches to accommodate
18 thread lead during make up or break out. An open
19 throat top guide plate 115 is fixed to the upper end
20 of legs 113 and is fitted with lifting eyes 117
21 which enable handling of the tong frame 110. An
22 optional remotely operated adjustable upper guide
23 plate assembly can be provided to facilitate hands
24 off stabbing of tubulars, and hence the remotely
25 operated adjustable upper guide plate assembly acts
26 as a hydraulic stabbing guide for the tubulars. The
27 tong frame 110 is approximately 39 inches wide by 39
28 inches deep.

29
30 The rotary bearing assembly 112 allows the
31 travelling slips 114 to rotate under load while the
32 pipe 17 is being manipulated. The rotary bearing

1 assembly 112 is attached to the upper end of the
2 cylinder plate 116 of the snubbing unit 20 and
3 features a flange (not shown) to accommodate the
4 travelling slip's 114 mounting bolts (not shown).
5 These loads are transferred into a large diameter
6 turntable bearing system (not shown) which runs
7 within a closed housing of the assembly 112 to guard
8 against contamination. An integral hydraulic swivel
9 system (not shown) allows continuous slip 114
10 operation without the need to connect or disconnect
11 hoses. The swivel features a cooling system (not
12 shown) to minimise heat build up in seals (not
13 shown) while the rotary bearing assembly 112 is
14 being used for extended drilling operations.
15 Preliminary specifications for the rotary bearing
16 assembly 112 are as follows.

17
18 Compressive load rating 460,000 pounds
19
20 Tense (snubbing) load
21 rating 170,000 pounds
22
23 Rotational speed limit (swivel
24 seal rating) 106 rpm
25
26 Maximum swivel pressures (static
27 non-rotating conditions) 1500 psi
28 (note pressure should be bled off swivel while
29 rotating)
30
31 Maximum swivel coolant pressure 60 psi
32 -

1 Recommended swivel coolant supply

2 flow rate 5 - 10 gpm

3

4 The swivel should be cooled by fresh water although
5 glycerol based antifreeze or equivalent may be
6 required in cold climates.

7

8 A remote control and instrumentation console may
9 also be provided and which features direct acting
10 hydraulic control valves (not shown) to provide
11 control for the following:-

12

13 i) Tong motor direction manual directional control
14 which uses a Danfoss PGV 120™ load independent
15 proportional hydraulic control valve assembly
16 (not shown) for open loop power unit with a
17 manual lever operated valve section to control
18 the tong motor with flow rates to 47.6 gpm.

19

20 ii) Tong motor mode (high torque, low speed or low
21 torque, high speed).

22

23 iii) Tong torque limiter (manual preset for
24 automatic dumping, and an electronic solenoid
25 can add computer dump control).

26

27 iv) Tong backing pin.

28

29 v) Hydraulic system pressure control.

30

31 vi) Rotary back up motor manual directional control

1 which uses a hydraulic control valve assembly
2 for open loop power unit with a manual lever
3 operated valve section. One section controls
4 the rotary back up 109 motors with flow rates
5 to 145 gpm which is the maximum allowable flow
6 rate for continuous operation in high speed
7 mode. Infinitely variable rotational speed
8 control may be achieved most efficiently
9 through the use of variable displacement pump
10 systems. Alternatively, the speed may be
11 adjusted by throttling the direction of control
12 valve or through the use of an adjustable flow
13 control valve.

14

15 vii) Rotary back up 109 motor mode providing for
16 high torque, low speed or low torque, high
17 speed.

18

19 viii) Tong backing pin for the rotary back up 109.

20

21 ix) Braking system control.

22

23 x) Torque gauge (hydraulic style) with dampener
24 valve.

25

26 xi) Hydraulic system pressure gauge.

27

28 Referring now back to Fig. 8a, a tripping operation
29 into an already drilled borehole will now be
30 described. By way of explanation, a tripping
31 operation is performed to insert tools required in
32 the borehole for a specific downhole operation.

1 With boreholes being many thousands of feet deep,
2 the length of drill pipe 17 must be included in the
3 drill string and inserted into the borehole as
4 quickly as possible.

5

6 A make up/break out mechanism in accordance with the
7 present invention will now be described.

8

9 Fig. 8a shows the upper end of drill pipe 17c
10 projecting upwardly from the snubbing unit 20. At
11 this point, the fixed slips 124, which are located
12 within a fixed slip housing 3, are energised to
13 firmly grip against the outer surface of the lower
14 end of drill pipe 17c, such that the fixed slips 124
15 are holding the entire weight of the drill string.
16 The four hydraulic jacking cylinders 122 are then
17 actuated to raise the snubbing unit 20 upwards until
18 it reaches the position shown in Figs. 7a and 9a,
19 such that the upper end of drill pipe 17c and lower
20 end of drill pipe 17b are located within the
21 snubbing unit 20. The travelling slips 114 are then
22 energised to engage the outer surface of drill pipe
23 17c just below the upper end thereof. The jaws of
24 the rotary back up 109 are then energised to engage
25 the outer surface of drill pipe 17c immediately
26 below the upper end thereof and the jaws of the
27 upper tong 108 are energised to engage the outer
28 surface of drill pipe 17b immediately above the
29 lower end thereof. The fixed slips 124 are then
30 released and the hydraulic jacking cylinders 122 are
31 then actuated to move the snubbing unit 20
32 downwardly. Simultaneously, the upper tong 108 is

1 operated to rotate drill pipe 17b relative to drill
2 pipe 17c such that the two joints thereof are made
3 up to the required torque level. Therefore, by the
4 time snubbing unit 20 has reached the position shown
5 in Fig. 10a, the joint between drill pipe 17b and
6 17c has been made up. The pipe handler fluid swivel
7 13b can then be disengaged from the upper end of
8 drill pipe 17b and can be moved downwardly on the
9 arm runner 9b, as shown in Figs. 11b and 12b to pick
10 up another pipe 17. The fixed slips 124 are then
11 re-energised to engage the outer surface of drill
12 pipe 17b, and when this has been done, the
13 engagement between upper tong 108, rotary back up
14 109 and the respective drill pipe 17b, 17c can be
15 released. The hydraulic jacking cylinders 122 are
16 then actuated once more such that the snubbing unit
17 20 moves to the configuration shown in Fig. 13a.
18 The travelling slips 114 are re-energised to grip
19 the drill pipe 17 and the fixed slips 124 are
20 released. The hydraulic jacking cylinders 122 are
21 then actuated to move downwardly such that the
22 snubbing unit 20 and travelling slips 114 stroke the
23 drill string 17 into the borehole. A typical length
24 of travel of the hydraulic jacking cylinders 122,
25 and hence stroke of the drill string 17, is 13 feet.
26 The snubbing unit 20 therefore moves from the
27 configuration shown in Fig. 13a to the configuration
28 shown in the Fig. 14a and 15a. Additionally,
29 articulated pipe arms 12a have moved pipe 17a to be
30 co-axial with the drill pipe 17b.

1 The fixed slips 124 are once again energised to
2 engage the drill pipe 17b and the travelling slips
3 114 are released, such that the hydraulic jacking
4 cylinders 122 move the snubbing unit 20 to the
5 configuration shown in Fig. 16a so that the upper
6 end and lower end of respective drill pipes 17b and
7 17a are located within the snubbing unit 20.

8
9 This process is repeated for as many drill pipe 17
10 sections as required in order to make up the desired
11 length of drill string 17.

12
13 This process provides an extremely quick make up (or
14 if operated in reverse, break out) for a tripping
15 operation.

16
17 Normally, for tripping operations, rotation of the
18 drill string is not required. However, for drilling
19 operations, the drill string 17 is required to be
20 rotated and also requires that circulation occurs
21 through the bore of the drill string 17 down to the
22 drill bit located at the bottom of the drill string
23 17. The drilling rig 100 is capable of imparting
24 rotary movement to the drill string 17 without the
25 requirement for a conventional rotary table or top
26 drive, and can also provide continuous circulation
27 through the bore of the drill string 17, as will now
28 be described.

29
30 The travelling slips 114, as previously described,
31 are used to lower the drill string 17 into, or raise
32 the drill string 17 from, the borehole, and the

1 control system for the hydraulic jacking cylinders
2 can be operated such that the cylinders 122 can push
3 the drill string 17 into the hole. For instance,
4 the drilling operation may require that the drill
5 string 17 is forced down into the hole by a certain
6 percentage of weight of drill pipe 17, such as 10%
7 weight. The rotary bearing assembly 112 and the
8 travelling slips 114 can also be operated to impart
9 rotation to the drill string 17, either as it is
10 being inserted into, or pulled from the borehole, or
11 even whilst the drill string 17 is vertically
12 stationary.

13

14 Additionally, or alternatively to the rotary bearing
15 assembly providing the power to rotate the drill
16 string 17, the rotary backup 109 can be operated to
17 impart rotation to the drill string 17.

18

19 A continuous circulation apparatus and method in
20 accordance with the present invention will now be
21 described, which is particularly for use during a
22 milling/drilling operation.

23

24 Figs. 18 to 23 show a portion of an apparatus 130 of
25 the continuous circulation system, with Figs. 24 to
26 28 showing flow diagrams for the operation thereof.
27 Fig. 19 shows the continuous circulation apparatus
28 130 in isolation, and Fig. 18 shows the continuous
29 circulation apparatus 130 incorporated in the
30 snubbing unit 20. Referring firstly to Fig. 19,
31 there is shown a first embodiment of apparatus 130
32 as comprising an upper seal 132 in the form of a

1 shaffer sealing element 132, a lower seal in the
2 form of a pair of rams 134a, 134b and a middle full
3 bore valve 136 in the form of a 10,000 psi plate
4 valve 136. Housing for these components is also
5 provided in the form of a shaffer type bonnet 138,
6 centre housing 140 and a main housing 142. The
7 shaffer seal 132 is provided with a piston assembly
8 144 which can be moved upwardly to energise the
9 shaffer seal 132 around the outer surface of a pipe
10 17 located in the bore of the shaffer seal 132 by
11 the introduction of pressured hydraulic fluid into
12 sealed closed port 146. The piston assembly 144 can
13 be moved downwardly to release the sealing action of
14 the shaffer seal 132 on the drill pipe 17 by
15 introduction of hydraulic fluid into the seal open
16 port 148.

17
18 It is important to note that the centre spindle 137
19 of the plate valve 136 is not located on the
20 intended path of the longitudinal axis of the drill
21 string 17. However, the main working plane of the
22 plate valve 136 is perpendicular to the longitudinal
23 axis of the intended path of travel of the drill
24 string 17. A pair of circular apertures 150a, 150b
25 are provided in the plate valve 136, and a pair of
26 sealing rings 152a, 152b are provided on the upper
27 surface of the plate valve 136, such that the
28 centres of the apertures 150a, 150b and sealing
29 rings 152a, 152b are located at the same radius from
30 the centre spindle 137. Furthermore, the centres of
31 the apertures 150a, 150b are located on the same
32 diameter, and the centres of the sealing rings 152a,

1 152b are also located on the same diameter. The
2 valve plate 136 is arranged such that, with the
3 centre spindle 137 being off centre of the
4 longitudinal axis of the drill string 17, the centre
5 point of the apertures 150a, 150b and sealing rings
6 152a, 152b bisect the longitudinal axis of the drill
7 string 17 as the valve plate 136 rotates. In other
8 words, the centre spindle 137 is located off centre
9 by a distance equal to the radius of the centre
10 lines of the apertures 150 and sealing rings 152.

11

12 As shown most clearly in Fig. 20, a circulating port
13 154 is formed immediately vertically below the
14 location of the plate valve 136 and immediately
15 vertically above the pipe rams 134a, 134b.

16

17 The inner faces of the pipe rams 134a, 134b are
18 formed such that when the rams 134 are brought
19 together, they provide a sealing fit around the
20 outer surface of the drill pipe 17.

21

22 The plate valve 136 is provided with a gearing
23 surface 156, and an internal hydraulic motor 158
24 with an appropriately geared drive is also provided,
25 such that actuation of the hydraulic motor 158
26 rotates the plate valve 136.

27

28 Optionally, but preferably, a further port 220 (as
29 shown in Fig. 24) is provided into the inner chamber
30 of the continuous circulation apparatus 130, where
31 the further port 220 is located in between the
32 shaffer sealing element 132 and the plate valve 136.

1 The further port 220 can be opened to purge air from
2 the pipe joint 17B being introduced into the
3 apparatus 130 prior to the plate valve 136 being
4 opened; in this manner the shaffer seal 132 is first
5 closed around the pipe joint 17B and the further
6 port 220 is opened such that air may be flushed out
7 or pumped out of the joint 17B.
8
9 Optionally, but preferably, a joint integrity
10 checking apparatus is further provided for use with
11 the continuous circulation apparatus 130; the joint
12 integrity apparatus (not shown) provides an external
13 pressure check on the integrity of the pipe joints
14 that are made up within the continuous circulation
15 apparatus 130. In order to utilise the joint
16 integrity apparatus, the pipe joint to be checked is
17 maintained within the middle of the continuous
18 circulation apparatus 130, that is in the position
19 shown in Fig. 25. The rams 134A, 134B are
20 maintained in the closed configuration, such that
21 they seal about the upper end of the lower pipe 17C.
22 Then, either a fluid or more preferably a gas, such
23 as nitrogen or most preferably helium, is introduced
24 under pressure into the chamber (the portion
25 intermediate the circulation port 154 and injection
26 port 184) through either the circulating port 154 or
27 the injection port 184 until the pressure of the
28 fluid or gas reaches a relatively high fixed
29 pressure. A pressure sensor (not shown), which is
30 preferably a digital pressure sensor, is provided in
31 either the circulating port 154 or the injection
32 port 184 lines and the output of the pressure sensor

1 is preferably coupled to a computer control system
2 that is recording the whole activity of the rig 100;
3 the computer control system typically being located
4 in the rig cabin 31. The computer control system
5 (not shown) monitors the output of the pressure
6 sensor, such that if the output of the pressure
7 sensor starts to fall then the integrity of the pipe
8 joint between the lower pipe 17C and the upper pipe
9 17B is questionable. Such a questionable pipe joint
10 connection could be due to a number of factors such
11 as, but not limited to:-

- 12
- 13 1) wear and tear of the joint;
 - 14
 - 15 2) contamination within the screw thread
 - 16 connections of the joint;
 - 17
 - 18 3) insufficient torque being applied to the joint;
 - 19 and/or
 - 20
 - 21 4) excessive jawing or washout passing through the
 - 22 joint on previous trips of the joint into a
 - 23 borehole.
 - 24

25 A second embodiment of a continuous circulating
26 apparatus 160 is shown in schematic form in Fig. 26
27 and comprises an upper seal 162, which may be in the
28 form of a shaffer sealing element 162, similar to
29 that shown in Fig. 19, a lower seal 164, again in
30 the form of a shaffer sealing element and a plate
31 valve 166, similar to that shown in Fig. 19. This
32 embodiment is termed a stripper design 160. With

1 regard to the stripper design 160, it should be
2 noted that the upper seal may alternatively be a
3 rubber pack off element 162 in the form of a rubber
4 ring 162. This provides a friction seal with
5 respect to the outside surface of the pipe 17 or
6 pipe joint and does not require to be actuated. The
7 inner diameter of the rubber ring 162 is slightly
8 less than the outer diameter of the pipe 17, and the
9 rubber ring 162 is elastic such that it can deform
10 to allow the passage of joints therethrough. The
11 lower seal element 164 of the stripper design may
12 have a similar rubber ring 164.

13

14 A third embodiment of a continuous circulating
15 apparatus 170 is shown in Figs. 27 and 28 and
16 comprises an upper seal 172 in the form of a pair of
17 rams 172 similar to the rams 134 shown in Fig. 19, a
18 lower seal 174 in the form of rams 174, similar to
19 the rams 134 shown in Fig. 19, and a centre valve
20 176 in the form of a pair of full bore sealing rams
21 176. This third embodiment 170 is termed a ram
22 design 170.

23

24 A method of operating the continuous circulating
25 system will now be described.

26

27 For drilling operations, the lower end of a kelly
28 hose 180 is attached to the upper end of the next
29 drill pipe 17 to be made up into the drill string,
30 with the upper end of the kelly hose 180 being
31 coupled to the pipe handler fluid swivel 13. A
32 drilling fluid supply conduit 182 is coupled to the

1 outer end of the goose neck pipe 18. Referring to
2 Fig. 9a, at this point in the circulation system
3 cycle, no drilling fluid is circulated through the
4 goose neck 18, and the relative locations of the
5 lower drill pipe 17c and upper drill pipe 17b within
6 the snubbing unit 20 is shown in schematic form in
7 Fig. 24 at this point. Valve V_3 , which is located
8 between the kelly hose 180 and the fluid supply
9 conduit 182, is shown as closed. At this point,
10 middle full bore valve, in the form of plate valve
11 136 is shown as being closed, in that one of the
12 sealing rings 152 is concentric with the
13 longitudinal axis of the drill pipe 17c. Lower valve
14 134 is closed around the outer surface of the upper
15 end of drill pipe 17c, and injection port 184 is
16 closed by means of valve V_2 . Valve V_4 is also closed
17 and which is located between the kelly hose 180 and
18 a bleed off line 186. Valves V_5 and V_1 are located
19 between the circulating port 154 and the fluid
20 supply conduit 182, and at this point, V_5 and V_1 are
21 both open, and hence drilling fluid is being
22 supplied through circulating port 154 and into the
23 inner bore of the snubbing unit 20 and hence inner
24 bore of the drill pipe 17c.

25

26 It should also be noted that the snubbing unit 20 is
27 provided with another slip system 190, in the form
28 of upper slips 190, and which will normally only be
29 utilised during a continuous circulating operation.
30 The upper slips 190 (not shown in Fig. 17(a) but
31 shown in schematic form in Figs. 24 and 25, and
32 shown in a preferred form in Figs. 29, 30 and 31)

1 are mounted to the upper end of a feeder plate 192
2 of the snubbing unit 20 by means of an arrangement
3 of hydraulic jacking cylinders 194, and in a
4 preferred embodiment, there are four such hydraulic
5 jacking cylinders 194. The upper slips 190 are
6 operable to firmly grip the drill pipe 17b as it is
7 being inserted into the snubbing unit 20, such that
8 the upper slips 190 provide support to the drill
9 pipe 17b, and the hydraulic jacking cylinders 194
10 are actuated to firmly lower or feed the drill pipe
11 17b into the snubbing unit 20.

12

13 The next stage of operation is shown in Fig. 25, and
14 which shows that the middle plate valve 136 has been
15 rotated such that an aperture 150 is co-axial with
16 the longitudinal axis of the drill pipes 17.
17 Simultaneously, the upper seal 132 is closed around
18 the upper pipe 17b, and valve V_3 is opened. This
19 flushes fluid into the drill pipe 17b and hence
20 equalises the pressure above the plate valve 136
21 with the pressure below the plate valve 136, since
22 valves V_5 and V_1 are still open.

23

24 The upper slips 190 remain actuated to firmly grip,
25 and hence support, the drill pipe 17b against the
26 force of the pressure which would otherwise force
27 the drill pipe 17b upwards and out of the snubbing
28 unit 20.

29

30 The plate valve 136 is then rotated to the position
31 shown in Fig. 25 such that one of the apertures 150

1 is concentric with the longitudinal axis of the
2 drill pipe 17. Valve V_1 is then closed.
3
4 Downward movement of the upper pipe 17b is again
5 commenced as previously described (i.e. by a
6 combination of downward movement of the wire pulley
7 10b and also downward movement of the hydraulic
8 jacking cylinders 194) until it comes into close
9 proximity with the upper end of lower pipe 17c.
10 Valve V_2 is then opened and a suitable fluid is
11 supplied into the injection port 184 via the now
12 open V_2 , in order to flush the threads of the two
13 pipes. Hence, the upper tong 108 and the lower tong
14 or rotary back up 109 are operated to grip the two
15 pipes 17b, 17c and the actuation of the upper slips
16 190 upon the drill pipe 17b is released.
17 Thereafter, the upper tong 108 and the lower
18 tong/rotary back up 109 are operated to make up the
19 two pipes 17b, 17c.
20
21 The drill string 17 continues its downward movement
22 by operation of the hydraulic jacking cylinders 122,
23 travelling slips 114 and fixed slips 124 until such
24 a time that the upper end of the pipe 17b is at the
25 thread engagement height; that is the location of
26 pipe 17c as shown in Fig. 24. The kelly valve is
27 then backed off the upper end of pipe 17b and is
28 pulled upwardly by the counterbalance winch and/or
29 the upper slips 190 and hydraulic jacking cylinders
30 194. It should be noted that upper seal 132 is
31 still sealing around the kelly valve. Once the
32 kelly valve has passed upwards through the aperture

1 150, the middle plate valve 136 is closed. Valve V_4
2 is then opened to bleed off pressure, and V_3 is
3 closed and V_5 is opened. The upper seal element 132
4 can then be opened and the next pipe joint can be
5 introduced into the snubbing unit 20. The method is
6 repeated for as many joints as required, and hence
7 continuous circulation of drilling fluid through the
8 drill string is achieved.

9
10 Figs. 29 to 31 show a preferred form of a slip
11 mechanism 200; it should be noted that the slip
12 mechanism 200 is preferably suitable for use as the
13 fixed/stationary slips 124 and/or travelling slips
14 114 and/or upper slips 190.

15
16 The slip mechanism 200 can also be referred to as a
17 snubbing slip mechanism 200. The slip mechanism 200
18 comprises a slip bowl 202 or slip housing 202 which
19 is provided with at least one, and preferably four,
20 hydraulic jacking cylinders 204 which extend
21 vertically upwardly from the base of the slip
22 housing 202. Four snubbing slips 206 are provided
23 within the slip housing 202 where the width of each
24 snubbing slip 206 circumscribes no greater than 90°
25 of a circle. The innermost faces of each of the
26 snubbing slips 206 have a common curvature such that
27 when they are in the closed configuration as shown
28 in Fig. 30, they 206 come together to form an inner
29 bore and are provided with a suitably gripable
30 surface such that they 206 are capable of securely
31 gripping the outer surface of the drill pipe 17 and
32 can thus support the weight of the drill string.

1 The inner surface of the slip housing 202 is tapered
2 outwardly from the base of the slip housing 202 to
3 the uppermost portion of the slip housing 202 and
4 four longitudinally extending slots (not shown) are
5 formed equi-distantly around the inner surface of
6 the slip housing 202. A longitudinally extending
7 dovetail shaped key (not shown) is provided on the
8 outer surface of each snubbing slip 206 such that
9 the dovetail shaped key engages in the respective
10 slot of the slip housing 202. The upper end of the
11 hydraulic jacking cylinders 204 are suitably coupled
12 to each snubbing slip 206 such that actuation of the
13 hydraulic jacking cylinders 204 moves the cylinders
14 204 from their home (non-stroked) configuration
15 shown in Fig. 30 to the fully stroked configuration
16 shown in Fig. 29; in this manner the snubbing slips
17 206 can be moved from the closed (and pipe gripping)
18 configuration shown in Fig. 30 to the open (and non-
19 pipe gripping) configuration shown in Fig. 29.

20

21 It should be noted that conventionally, particularly
22 when tubing such as casing and liner tubing (which
23 has a flush outer surface along its length) is being
24 passed through a set of slips, that a safety
25 mechanism is used. This conventional safety
26 mechanism comprises a manual clamp which is set
27 around the outer surface of the tubing and which
28 must be put on manually by an operator such as a
29 roughneck. This manually applied clamp is arranged
30 to act as a safety feature such that if the snubbing
31 slips 206 lose their grip on the smooth outer
32 surface of the casing/liner string then the manually

1 applied clamp will collide against the upper surface
2 of the snubbing slips, thus forcing them further
3 down the tapered surface and thereby increasing the
4 grip being applied by the snubbing slips to the
5 outer surface of the casing. However, this
6 conventional clamp arrangement is dangerous to apply
7 and also time consuming.

8
9 In accordance with the present invention a safety
10 slip 208 is mounted to the upper end of each
11 snubbing slip 206 by means of a biasing mechanism
12 such as a set of coiled springs 210; however, those
13 skilled in the art will appreciate that a different
14 type of biasing mechanism could be used, such as a
15 leaf spring or rubber/neoprene element (not shown)
16 or a lever arrangement as shown in the second
17 embodiment of Figs. 32 to 34. The coiled springs
18 210 are arranged to naturally bias the safety slips
19 208 away from the snubbing slips 206. When the
20 snubbing slips 206 are in the closed configuration
21 as shown in Fig. 30, they are gripping the casing
22 string or drill string 17 and the safety slips 208
23 are also gripping the outer surface of the string.
24 since the rear end or outermost end of each safety
25 slip 208 abuts against a safety slip stop 212 which
26 is conveniently mounted in a suitable manner to the
27 upper end of the snubbing slip 206. Even more
28 advantageously, the safety slip 208 is provided with
29 a moveable safety slip front 214, where the safety
30 slip front 214 is mounted to the safety slip back
31 208 by means of a dovetail shaped key (not shown)

1 and slot (not shown) arrangement provided on a
2 tapered surface, as shown in Fig. 31.

3
4 Accordingly, with the safety slip front 214 gripping
5 the casing string, if the casing string begins to
6 slip through the snubbing slips 206 when they are in
7 the closed configuration, the safety slip front 214
8 and then the safety slip back 208 will travel
9 downwardly with the casing string against the
10 biasing action of the coiled springs 210 until the
11 lower face of the front 214 and back 208 collide
12 with the upper face of the snubbing slips 206 across
13 the full cross-sectional area of the upper face of
14 the snubbing slips 206 (which are greater in cross-
15 sectional area than the lower face of the snubbing
16 slips 206). Accordingly, the aforementioned
17 collision causes the snubbing slips 206 to move
18 downwardly to grip the tubing string even more.
19 When the tubing string or drill string is ready to
20 intentionally move through the slip mechanism 200,
21 the cylinders 204 are actuated to stroke outwardly
22 from the closed configuration of Fig. 30 to the open
23 configuration of Fig. 29. In this manner, the
24 snubbing slips 206 and safety slips 208, 214 are
25 moved not only upwardly but outwardly away from the
26 tubing/drill string 17, and the safety slips 208,
27 214 are moved upwardly away from the snubbing slip
28 206 by the biasing mechanism 210, such that they
29 208, 214 return to their 208, 214 starting (spaced)
30 configuration.

31

1 Accordingly, the embodiment of the slip mechanism
2 provides an automatic safety slip 208, 214 device
3 that does not require manual intervention.
4

5 Figs. 32, 33 and 34 show an alternative arrangement
6 of the safety slips 208, 214 where the safety slips
7 208, 214 move in an arc via a hinge 218 and pivot
8 219 into engagement and out of engagement with the
9 tubing string or drill string 17, rather than in the
10 vertical movement shown in the embodiment of Figs.
11 29 and 30, where the arc movement is shown in Fig.
12 33 by arrow 216. In addition, the hinge 218 that
13 moves about the pivot 219, acts as a safety slip
14 stop 218, 219.
15

16 The aforementioned apparatus provides distinct
17 advantages over conventional work over and drilling
18 units. For instance, it is capable of making or
19 breaking connections while circulating and tripping
20 pipe in or out of the well bore. Furthermore, it
21 can replace a conventional rotary table and can be
22 rigged up on almost any drilling rig, platform,
23 drill ship or floater. For rig assist, the jacking
24 slips are picked up like a joint of pipe and simply
25 stabbed into the rotary table. The unit fits flush
26 with the rig floor and allows for normal rig pipe
27 handling to be used. In this scenario, there is
28 minimal or no learning curve for the rig personnel
29 to go through, and with there being no loose
30 equipment above the rig floor 8 associated with this
31 apparatus, the possibility of dropped objects has
32 been eliminated.

1

2 The unique articulating pipe handling arms 12 and
3 power tong 108, 109 make up provides the apparatus
4 100 with the ability to make tubular connections "on
5 the fly" with a continual trip speed of over 60
6 joints per hour being possible.

7

8 The apparatus 100 can be broken down into readily
9 liveable components. Furthermore, the continuous
10 circulation feature allows an operator to make and
11 break connections without stopping circulation of
12 fluid through the drill string. It is envisaged
13 that the system will minimise collapse of boreholes
14 and differential sticking without surging the
15 borehole formation.

16

17 Modifications and improvements can be made to the
18 embodiments herein described without departing from
19 the scope of the invention.

1 **CLAIMS:-**

2

3 1. A tong apparatus comprising:-

4 an upper tong having a gripping device for
5 gripping a tubular, the upper tong further
6 comprising a rotation mechanism to provide rotation
7 to the gripping device to provide rotation to said
8 tubular; and

9 a lower tong having a gripping device for
10 gripping a tubular, the lower tong further
11 comprising a rotation mechanism to provide rotation
12 to the gripping device to provide rotation to said
13 tubular.

14

15 2. A tong apparatus according to claim 1, wherein
16 a motive means is provided to actuate the respective
17 rotation mechanism of the upper and lower tongs.

18

19 3. A tong apparatus according to either of claims
20 1 or 2, wherein the lower tong further comprises a
21 turntable bearing means which support ring gear of
22 the gripping device.

23

24 4. A tong apparatus according to any preceding
25 claim, wherein the lower tong further comprises a
26 braking system which permits controlled release of
27 residual torque of a string of tubulars.

28

29 5. A tong apparatus according to any preceding
30 claim, further comprising a travelling slip
31 mechanism which is capable of engaging at least a
32 portion of the outer circumference of a tubular, and
33 preferably, the travelling slip is capable of being

1 rotated by means of a rotary bearing assembly
2 mechanism.

3

4 6. A tong apparatus according to claim 5, wherein
5 the travelling slip mechanism is provided with a
6 vertical movement mechanism which can be actuated to
7 move the travelling slip and the engaged string of
8 tubulars in one or both vertical directions.

9

10 7. A method of providing rotation to at least one
11 tubular, the method comprising:-

12 providing an upper tong having a gripping
13 device for gripping a tubular, the upper tong
14 further comprising a rotation mechanism to provide
15 rotation to the gripping device;

16 providing a lower tong having a gripping device
17 for gripping a tubular, the lower tong further
18 comprising a rotation mechanism to provide rotation
19 to the gripping device; and

20 operating at least the rotation mechanism of
21 the upper tong to provide rotation to said tubular.

22

23 8. A method according to claim 7, further
24 comprising operating the rotation mechanism of the
25 lower tong to provide rotation to said tubular.

26

27 9. An apparatus for circulating fluid through a
28 tubular string, the string comprising at least one
29 tubular, the apparatus comprising:-

1 a first fluid conduit for supplying fluid to
2 the bore of an upper tubular to be made up into or
3 broken out from the tubular string; and
4 a second fluid conduit for supplying fluid to the
5 bore of the tubular string.

6

7 10. An apparatus according to claim 9, wherein the
8 first fluid conduit is releasably engageable with an
9 upper end of the upper tubular.

10

11 11. An apparatus according to either of claims 9 or
12 10, wherein the first fluid conduit is provided with
13 a valve mechanism which is operable to permit the
14 flow of fluid into and/or deny the flow of fluid
15 into the first fluid conduit and/or upper end of the
16 tubular.

17

18 12. An apparatus according to any of claims 9 to
19 11, wherein one end of the second fluid conduit is
20 in fluid communication with a chamber, and the
21 second fluid conduit is provided with a valve
22 mechanism which is operable to permit the flow of
23 fluid into, or deny the flow of fluid into, the
24 second fluid conduit and/or the chamber.

25

26 13. An apparatus according to claim 12, wherein
27 the chamber is adapted to permit a tubular to be
28 made up into, or broken out from, a tubular string.

29

30 14. An apparatus according to either of claims 12

1 or 13, wherein the chamber comprises a bore which is
2 vertically arranged to be coincident with the
3 longitudinal axis of the mouth of a borehole.

4

5 15. An apparatus according to claim 14, wherein
6 the chamber comprises an upper port into which the
7 said tubular can be inserted into or removed from
8 the chamber.

9

10 16. An apparatus according to either of claims 14
11 or 15, further comprising a valve mechanism actuatable
12 to seal the bore of the chamber at a location below
13 the upper port.

14

15 17. An apparatus according to claim 16, further
16 comprising an upper seal located above the said
17 location, and where the upper seal is arranged to
18 seal around at least a portion of the circumference
19 of the said tubular.

20

21 18. An apparatus according to either of claims 15
22 or 16, further comprising a lower seal located below
23 the said location, and where the lower seal is
24 arranged to seal around at least a portion of the
25 circumference of the tubular string.

26

27 19. An apparatus according to claim 12 further
28 comprising a valve system comprising one or more
29 further valves is provided to control the supply of
30 fluid to the first fluid conduit valve mechanism and
31 second fluid conduit valve mechanism.

1

2 20. A method of circulating fluid through a tubular
3 string, the string comprising at least one tubular,
4 the method comprising:-

5 providing a first fluid conduit for supplying
6 fluid to the bore of an upper tubular to be made up
7 into or broken out from the tubular string; and
8 providing a second fluid conduit for supplying fluid
9 to the bore of the tubular string.

10

11 21. The method according to claim 20, comprising
12 the further steps of inserting the lower end of the
13 upper tubular into an upper port, where a valve
14 mechanism denies the flow of fluid into the first
15 fluid conduit.

16

17 22. The method according to claim 21, comprising
18 the further steps of operating the valve mechanism
19 to permit the flow of fluid into the first fluid
20 conduit and upper end of the tubular.

21

22 23. An apparatus for providing a seal with a
23 tubular to be made up in to or broken out from a
24 tubular string, the tubular string comprising at
25 least one tubular, the apparatus comprising:-

26 an upper seal device for sealing about a
27 portion of the outer circumference of the said
28 tubular to be made up onto or broken out from the
29 string;

30 a lower seal device for sealing about a portion
31 of the outer circumference of the string; and

1 the upper seal device comprising an elastomeric ring
2 which is adapted to have an inner diameter
3 substantially the same as the outer diameter of at
4 least a portion of the tubular.

5
6 24. Apparatus according to claim 23, wherein the
7 the lower seal device also comprises an elastomeric
8 ring which is adapted to have an inner diameter
9 substantially the same as the outer diameter of at
10 least a portion of tubular string.

11
12 25. A valve mechanism for providing a seal between
13 two tubulars, the valve mechanism comprising:-

14 a plate member which is capable of rotation
15 about an axis;

16 at least one bore formed through the plate
17 member;

18 the plate member being capable of movement
19 between a first configuration in which a portion of
20 the plate member obturates the longitudinal axis of
21 at least one of the tubulars; and

22 a second configuration in which the bore is
23 concentric with the longitudinal axis of at least
24 one of the tubulars.

25
26 26. A valve mechanism according to claim 25,
27 wherein the plate member is capable of being rotated
28 between a first configuration from which a portion
29 of the plate member obturates the longitudinal axis
30 of both of the tubulars, and a second configuration
31 in which the bore is concentric with the

1 longitudinal axis of both of the tubulars, both of
2 the tubulars being concentric with one another.

3

4 27. A valve mechanism according to either of claims
5 25 or 26, wherein the plate member is circular and
6 is arranged within a cylindrical chamber, such that
7 the radius of the plate member is perpendicular to
8 the longitudinal axis of both tubulars.

9

10 28. A valve mechanism according to claim 27,
11 wherein the centre axis of the plate member is off-
12 centre with respect to the longitudinal axis of both
13 tubulars.

14

15 29. A method of providing a seal between two
16 tubulars, the method comprising:-

17 providing a plate member which is capable of
18 rotation about an axis;

19 the plate member having at least one bore;

20 wherein the plate member is capable of being
21 rotated between a first configuration in which a
22 portion of the plate member obturates the
23 longitudinal axis of at least one of the tubulars
24 and a second configuration in which the bore is
25 concentric with the longitudinal axis of at least
26 one of the tubulars.

27

28 30. An apparatus to prevent at least one tubular
29 slipping therein, the apparatus comprising a first
30 arrangement of grips adapted to grip at least one of
31 the tubular(s), and a second arrangement of grips

1 adapted to grip the said tubular(s), characterised
2 in that the first and second arrangements of grips
3 are coupled to one another.

4

5 31. An apparatus according to claim 30, wherein the
6 first and second arrangements of grips are coupled
7 to one another by a biasing mechanism.

8

9 32. An apparatus according to claim 31, wherein
10 the biasing mechanism is arranged to bias the first
11 and second arrangements of grips away from one
12 another.

13

14 33. An apparatus according to any of claims 30 to
15 32, wherein at least one of each of the first and
16 second arrangements of grips comprise first and
17 second portions, wherein the first portion is
18 coupled to the second portion by a tapered surface,
19 and a moveable locking mechanism, such that the
20 first portion is capable of moving with respect to
21 the second portion along the tapered surface.

22

23 34. An apparatus according to any of claims 30 to
24 33, wherein the first arrangements of grips are
25 located vertically below the second arrangements of
26 grips and the first arrangements of grips comprise a
27 relatively large surface area for gripping the
28 tubular.

29

30 35. An apparatus according to claim 34, wherein the

1 second arrangement of grips comprise a relatively
2 smaller surface area for gripping the tubular.

3

4 36. An apparatus according to any of claims 30 to
5 35, wherein a lower face of the second arrangement
6 of grips is coupled to an upper face of the first
7 arrangement of grips, and the upper face of the
8 first arrangement of grips is of a larger surface
9 area than a lower face of the first arrangement of
10 grips.

11

12 37. An apparatus according to any of claims 30 to
13 36, wherein the first arrangement of grips comprise
14 a stop means for preventing movement of the second
15 arrangement of grips in a direction radially away
16 from the tubular being gripped.

1 / 32

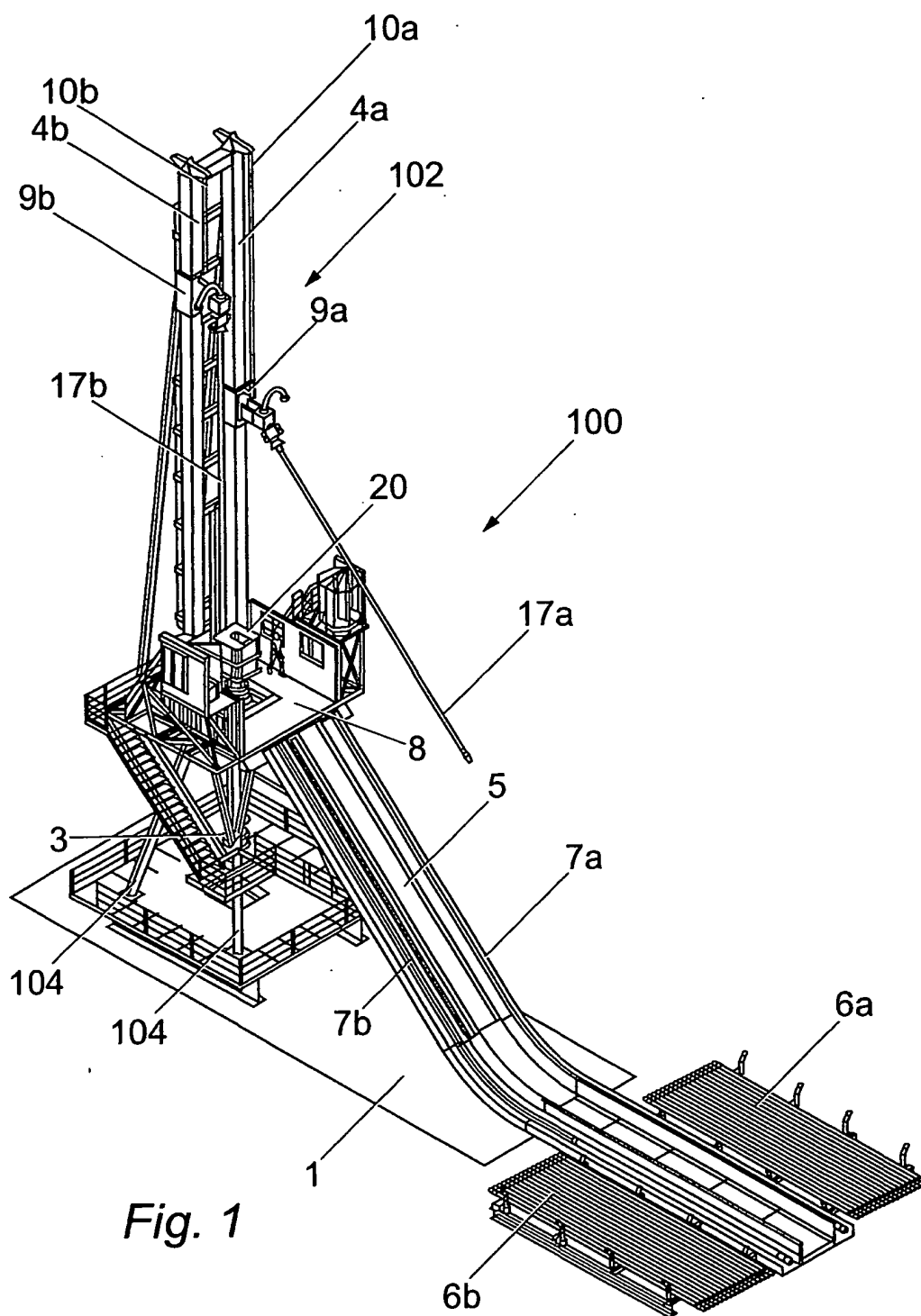


Fig. 1

2 / 32

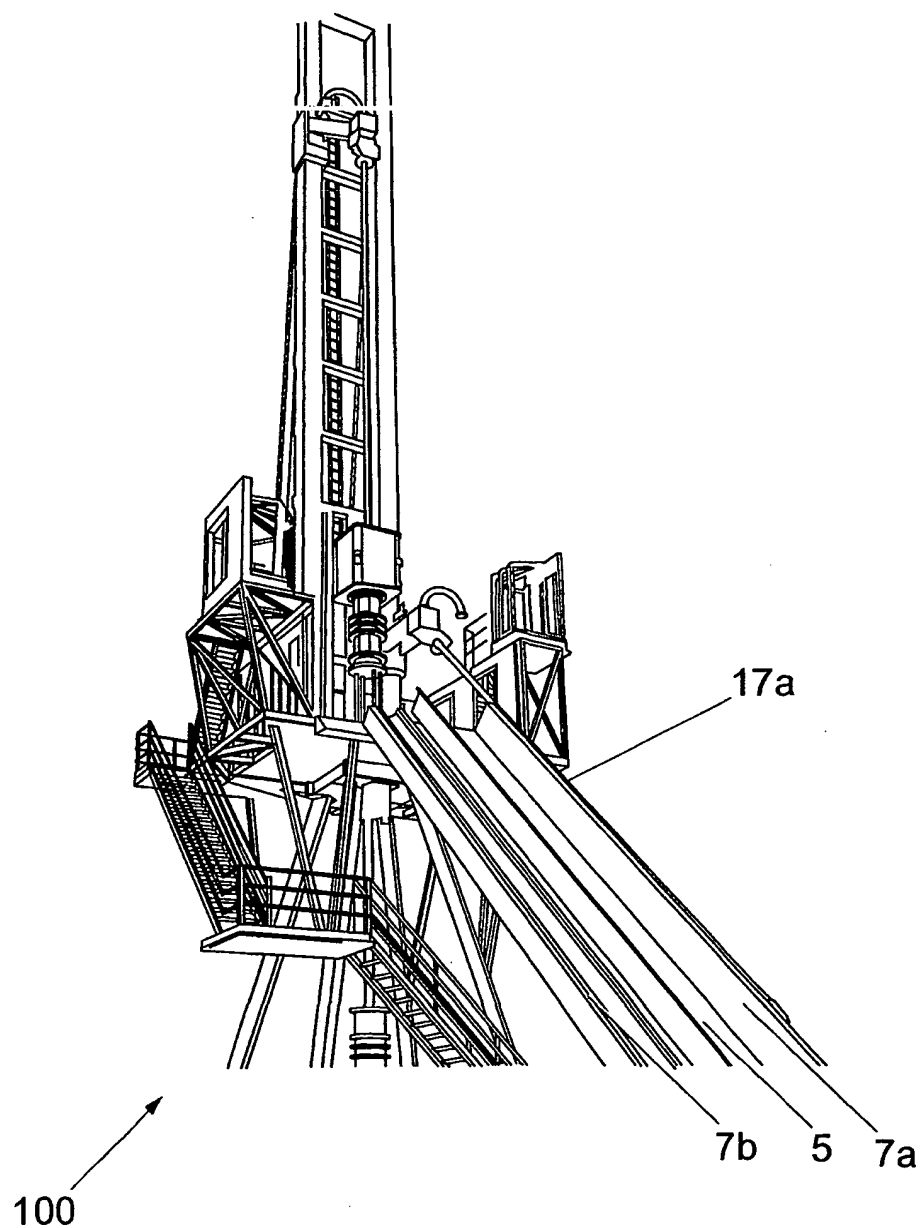


Fig. 2

3 / 32

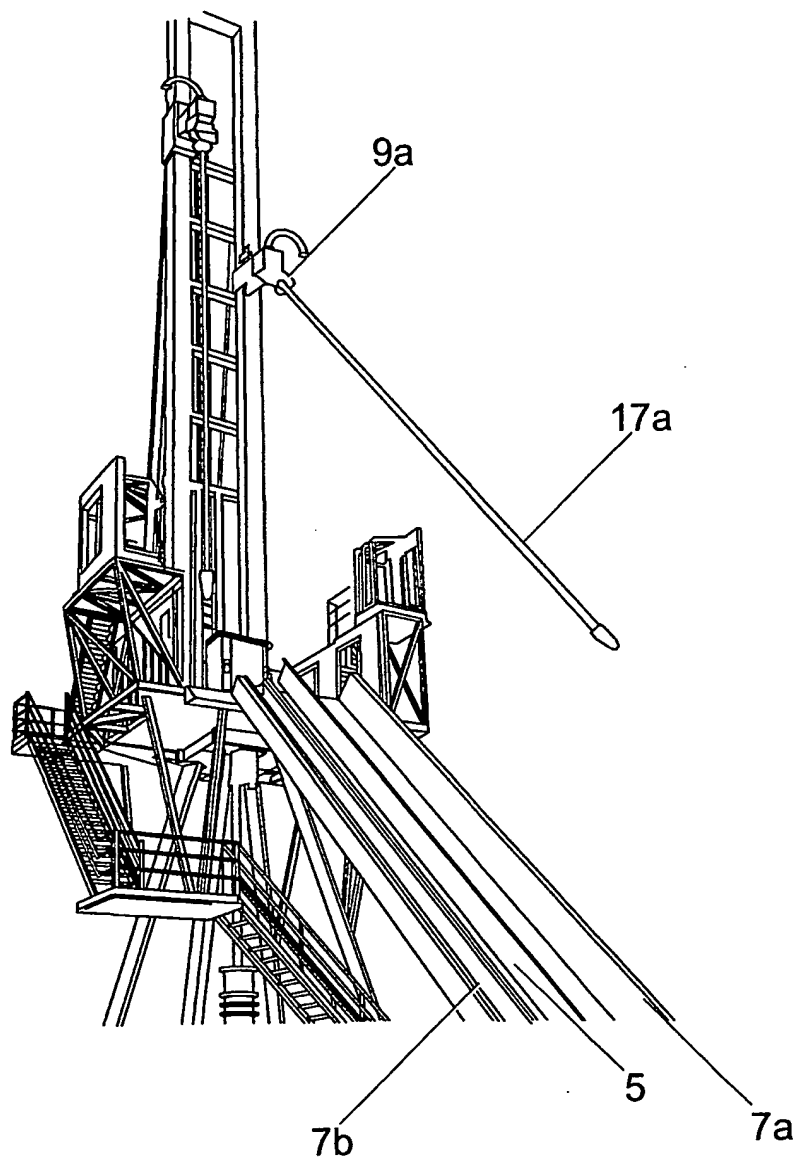


Fig. 3a

4 / 32

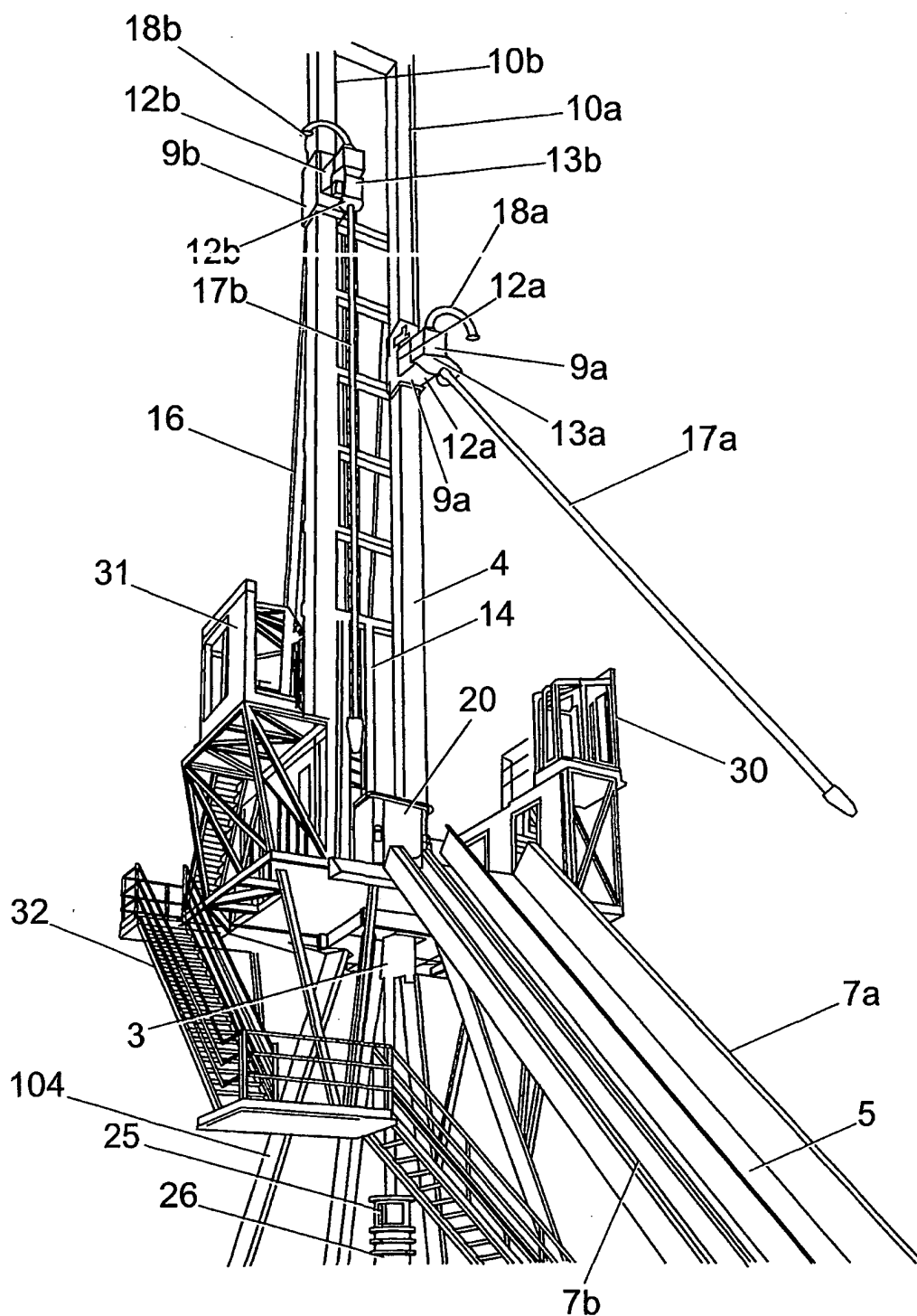


Fig. 3b

5 / 32

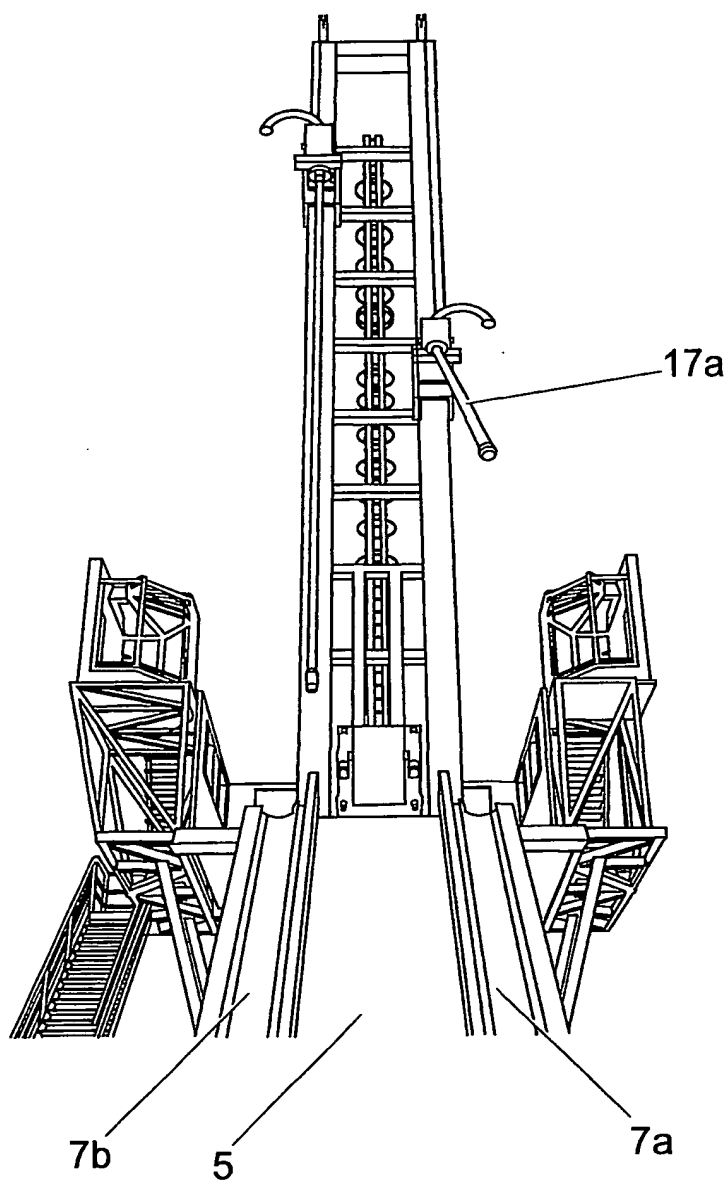


Fig. 4

6 / 32

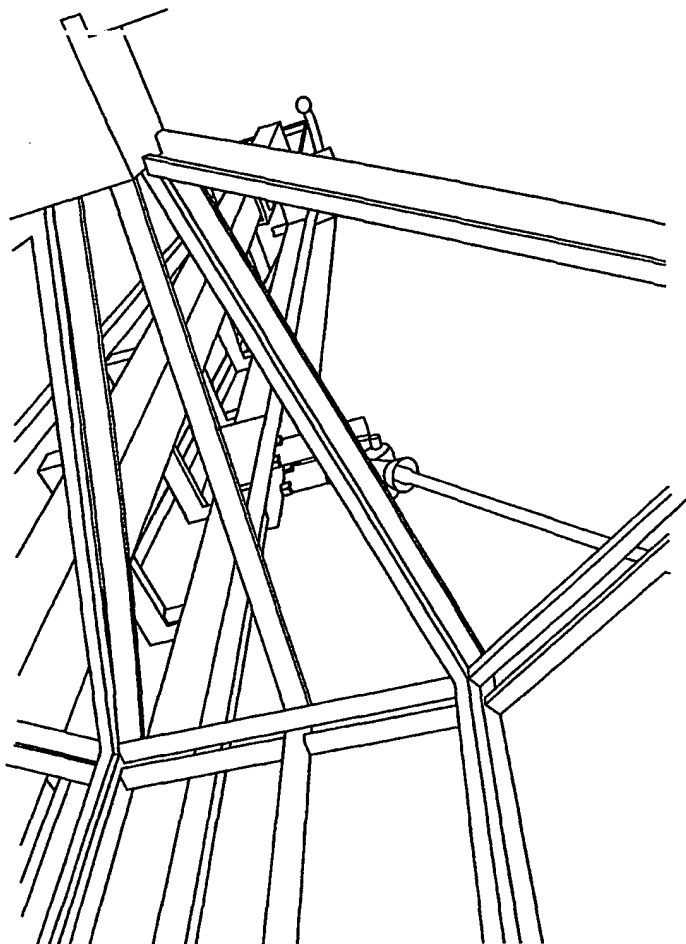


Fig. 5

7 / 32

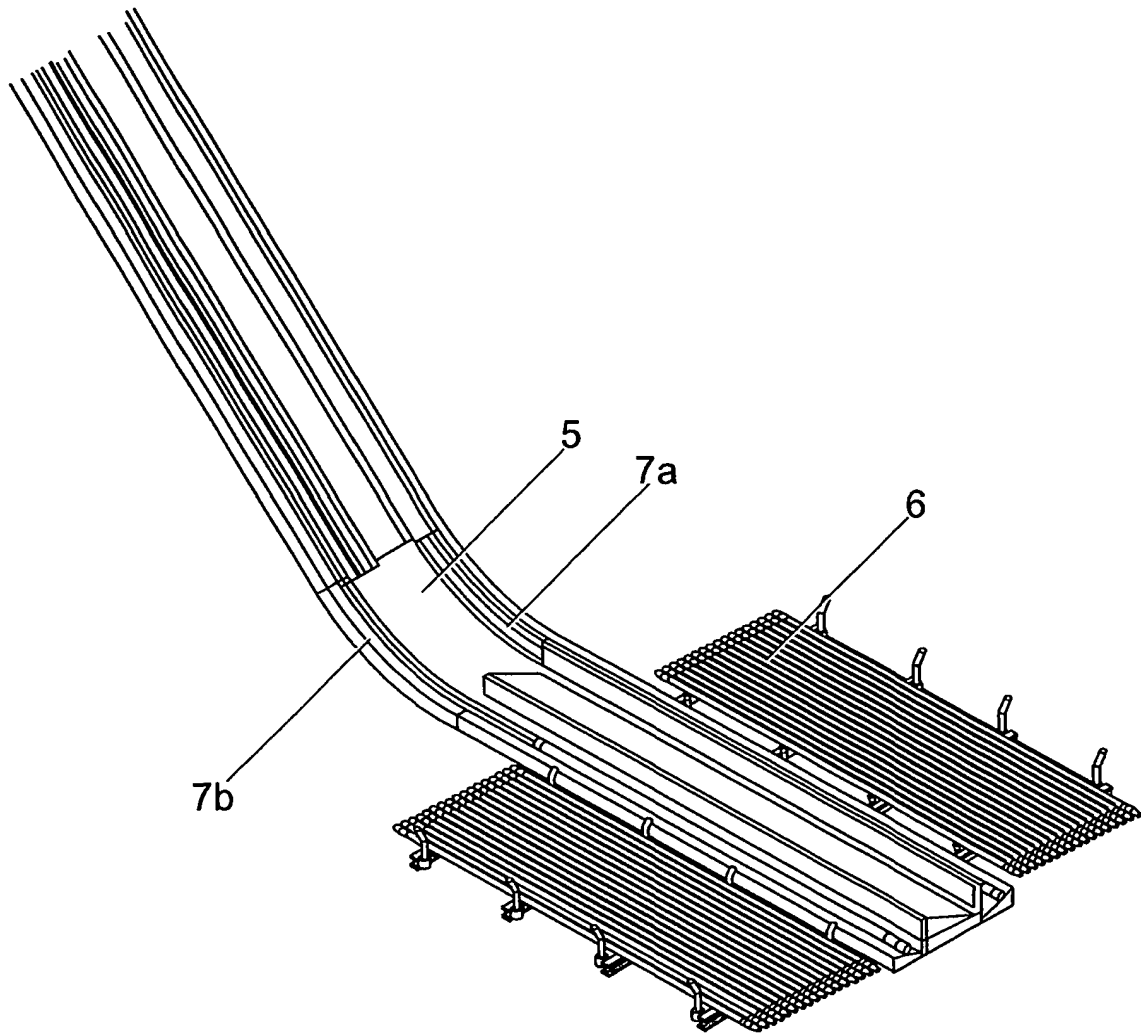


Fig. 6

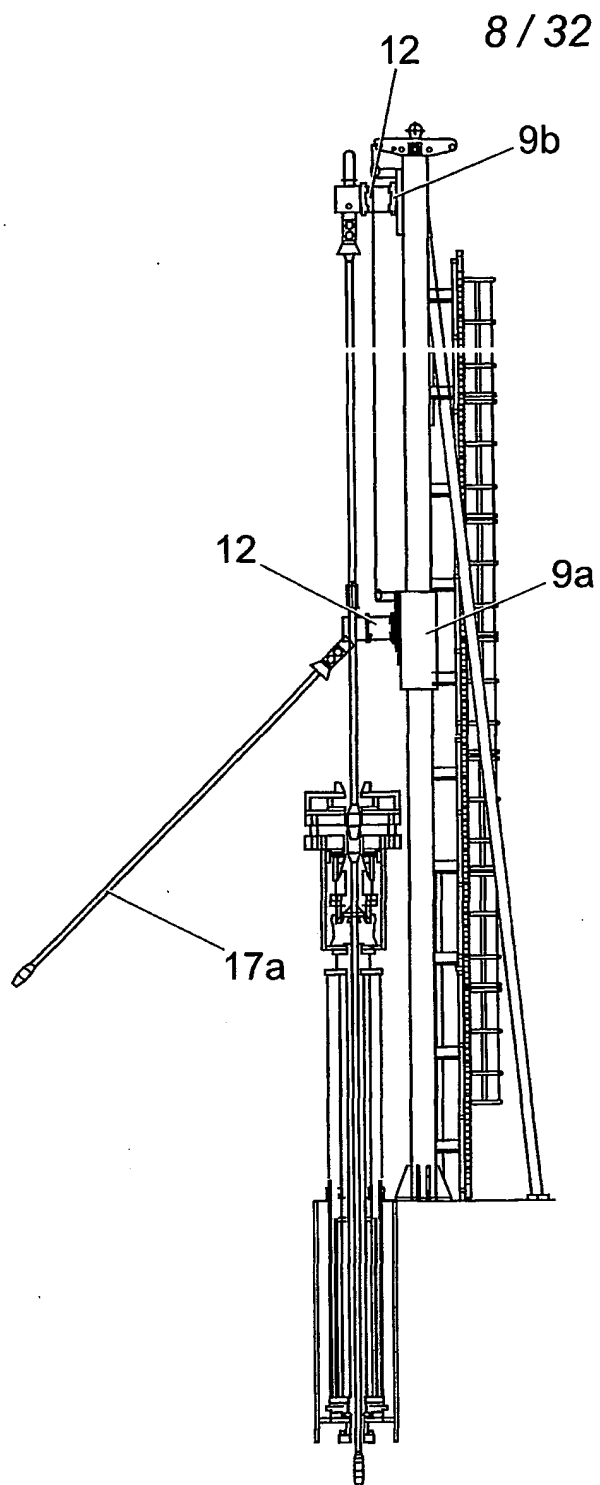


Fig. 7a

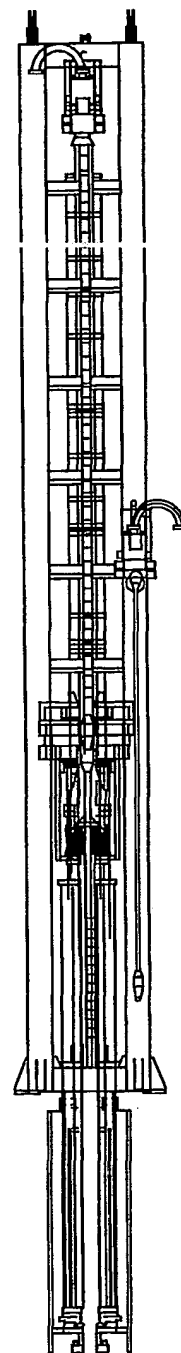


Fig. 7b

9 / 32

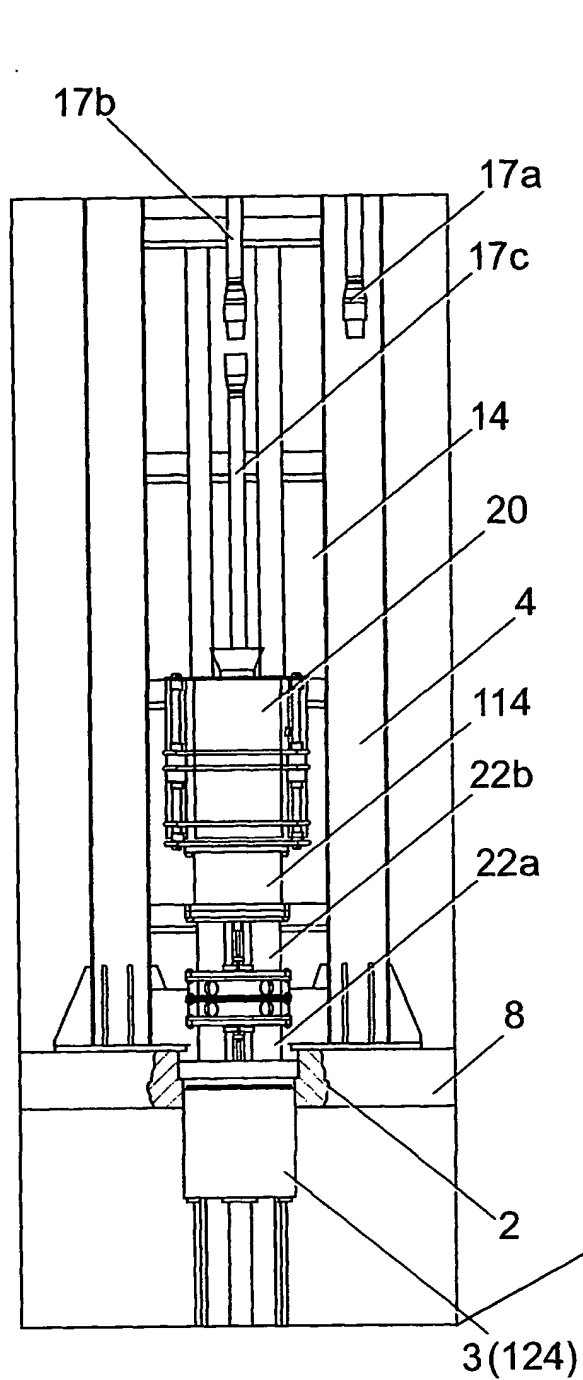


Fig. 8a

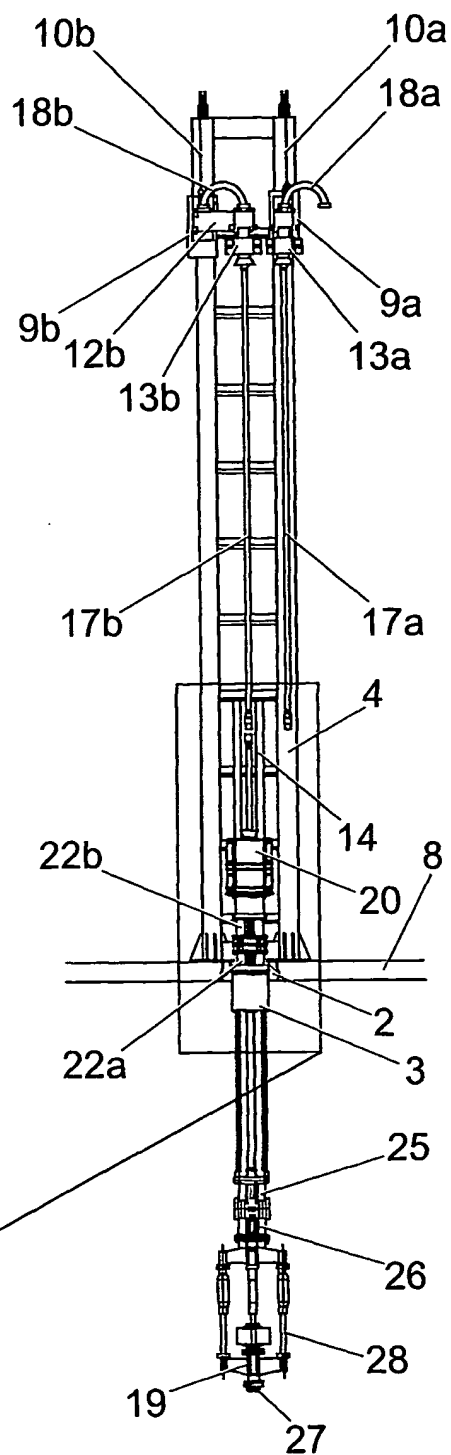


Fig. 8b

10 / 32

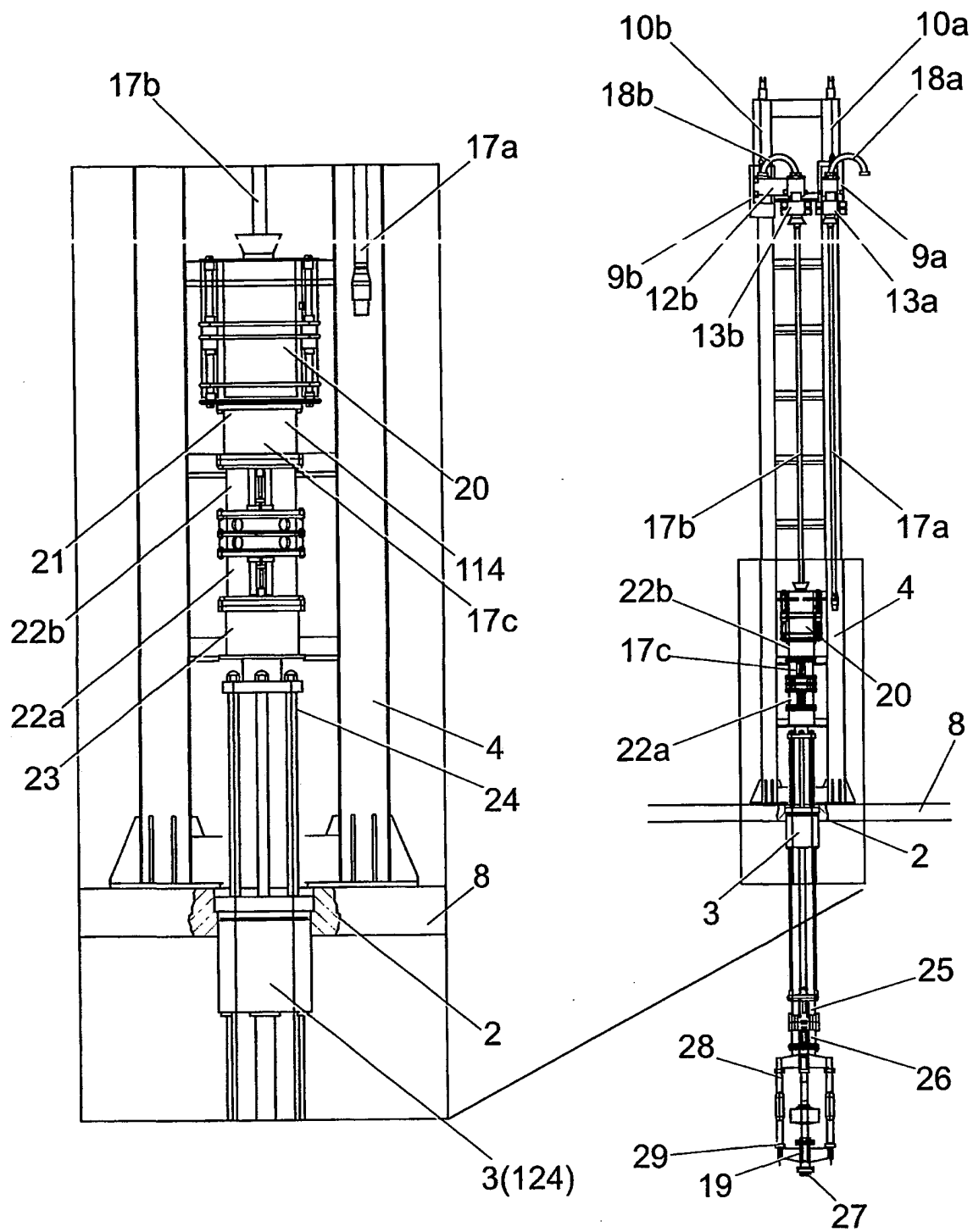


Fig. 9a

Fig. 9b

11 / 32

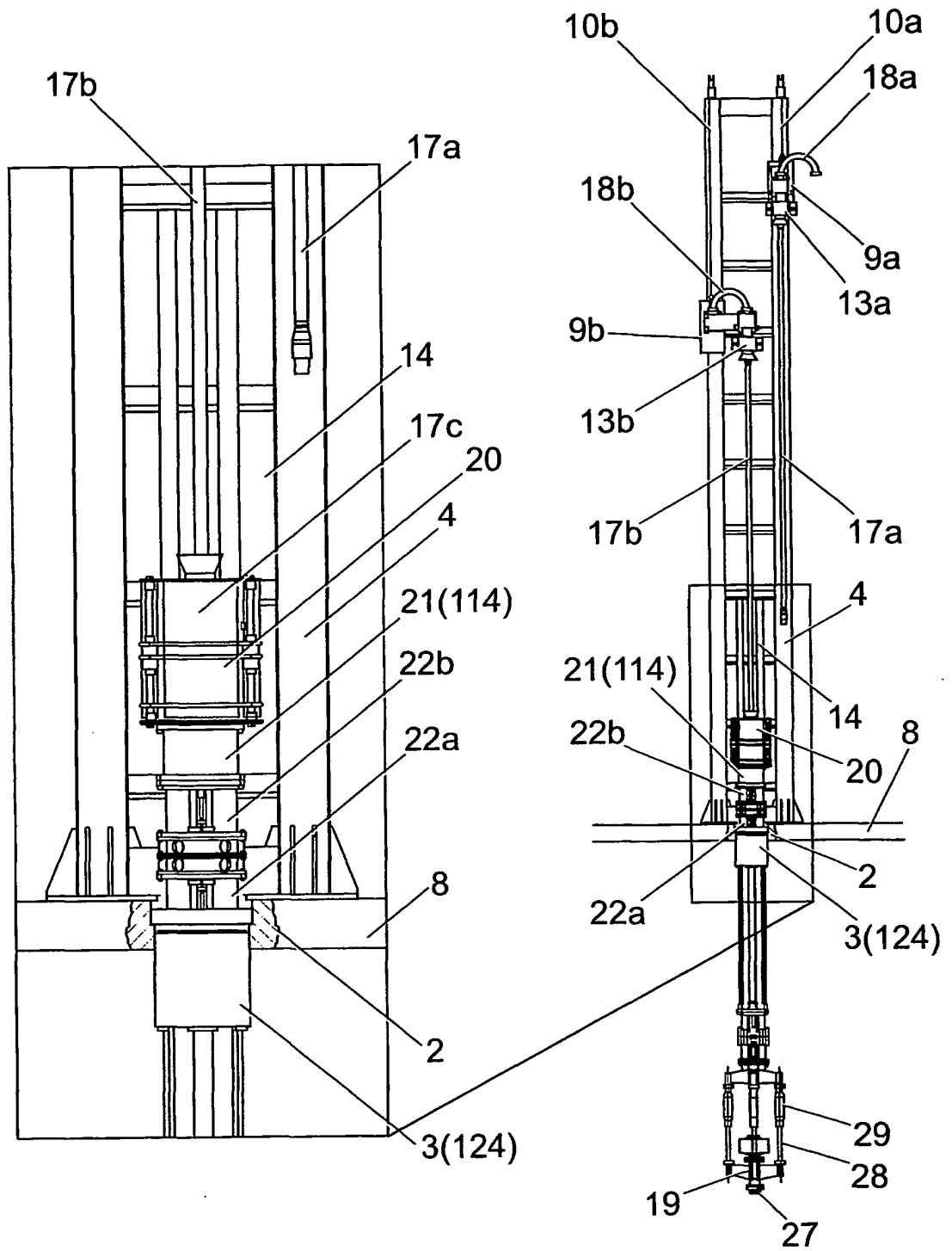


Fig. 10a

Fig. 10b

12 / 32

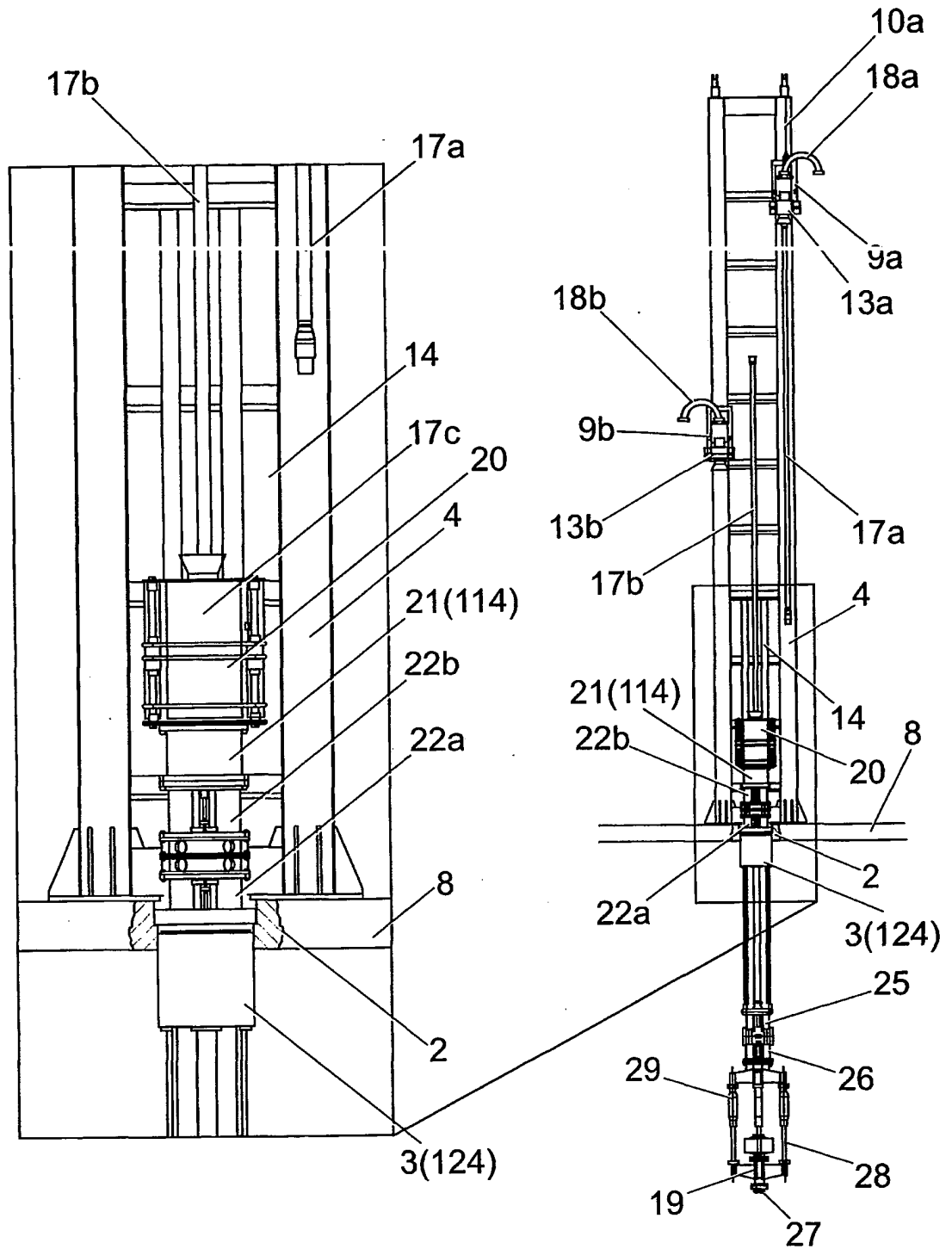


Fig. 11a

Fig. 11b

13 / 32

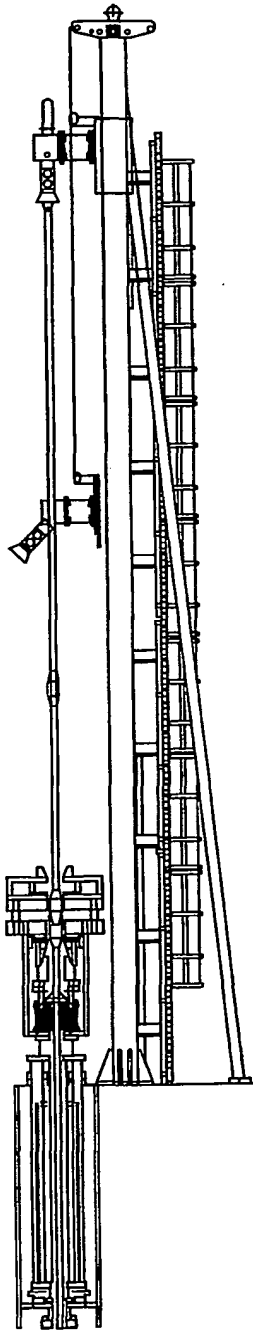


Fig. 12a

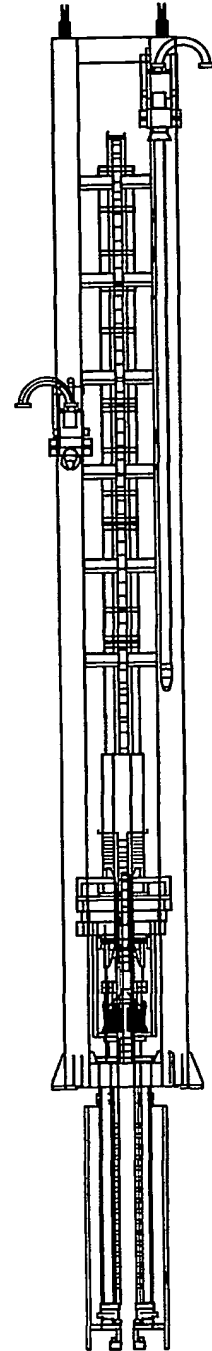


Fig. 12b

14 / 32

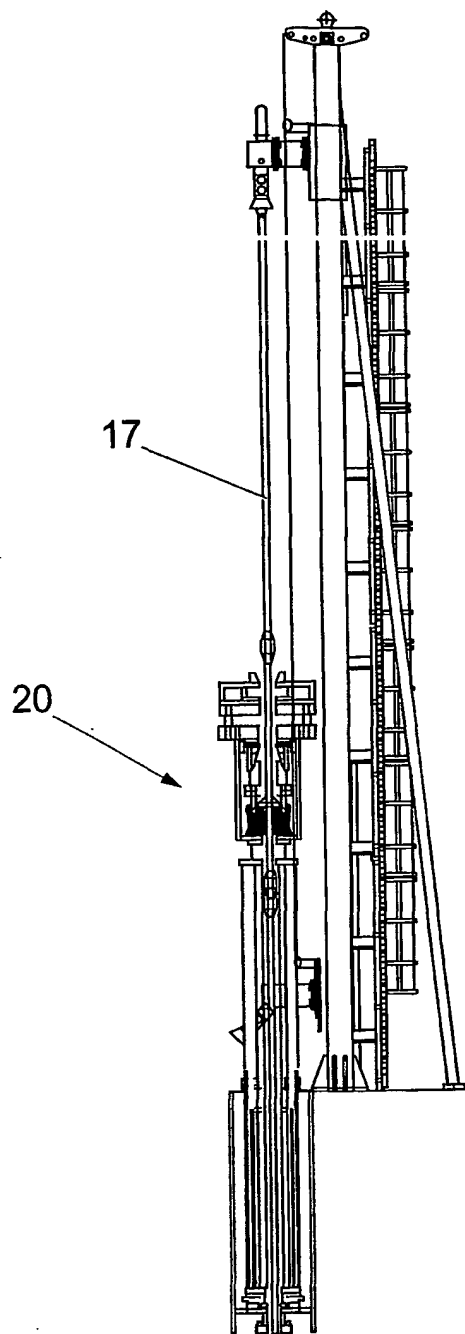


Fig. 13a

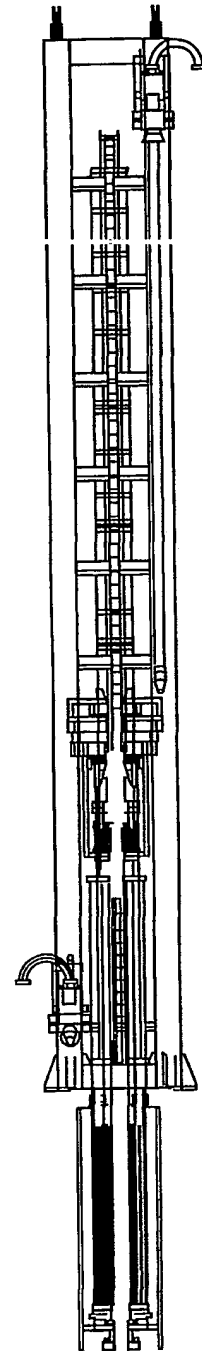


Fig. 13b

15 / 32

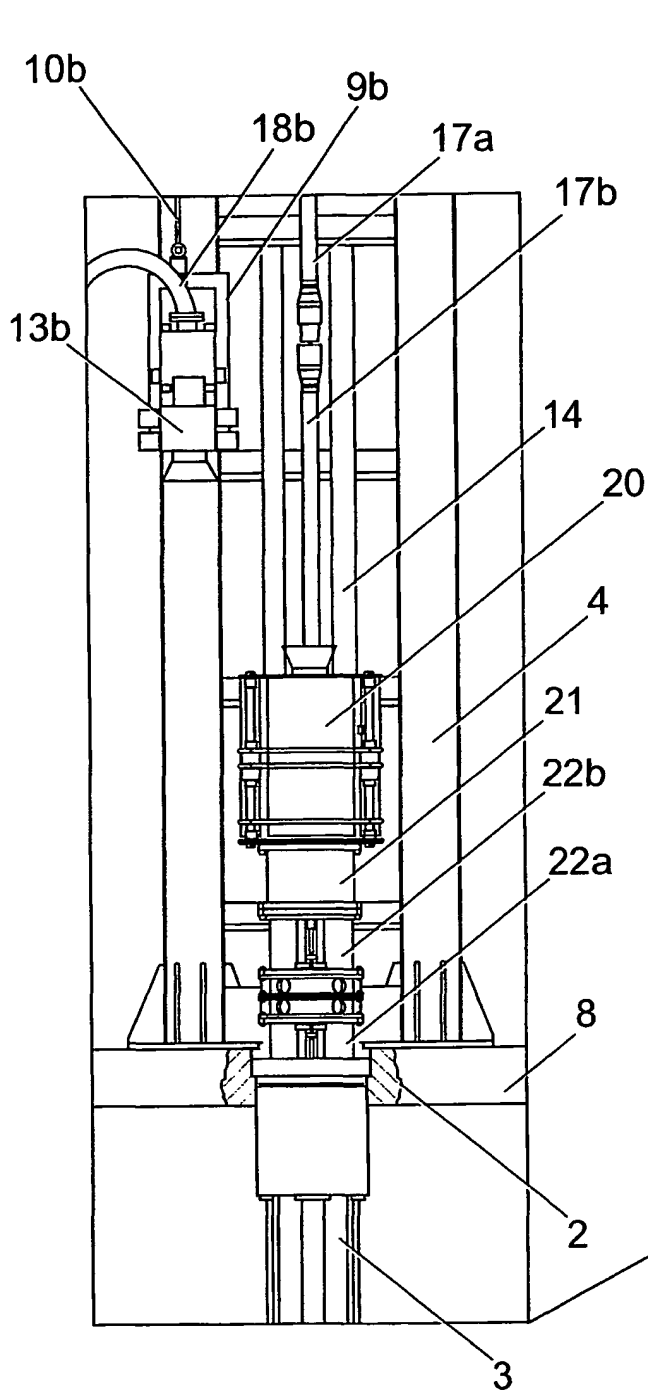


Fig. 14a

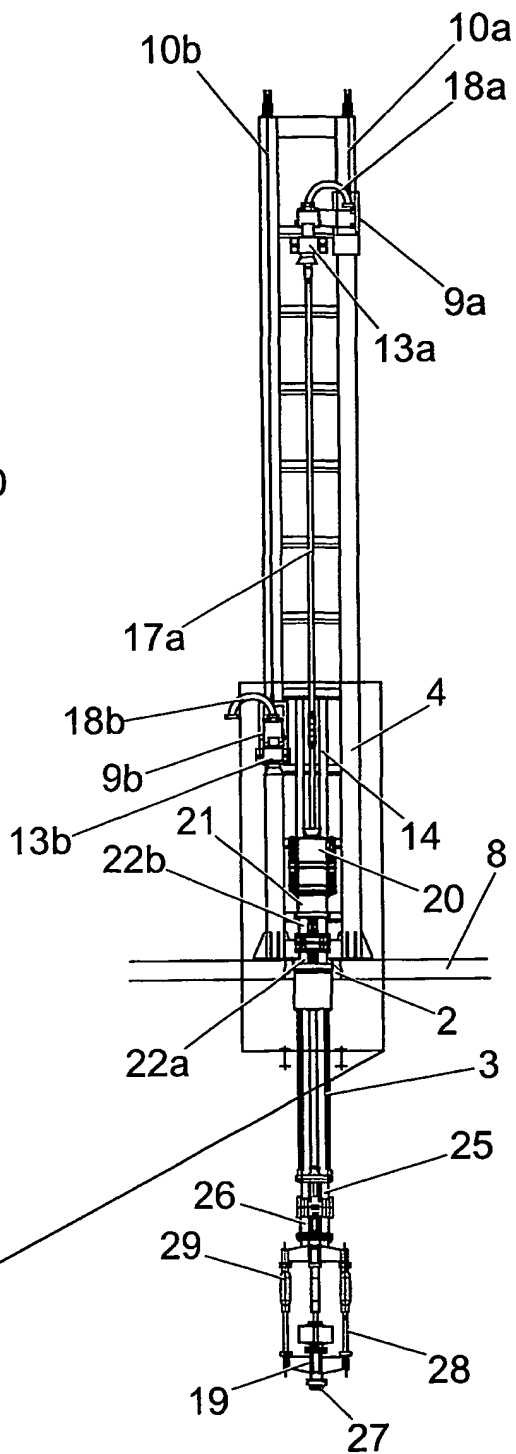


Fig. 14b

16 / 32

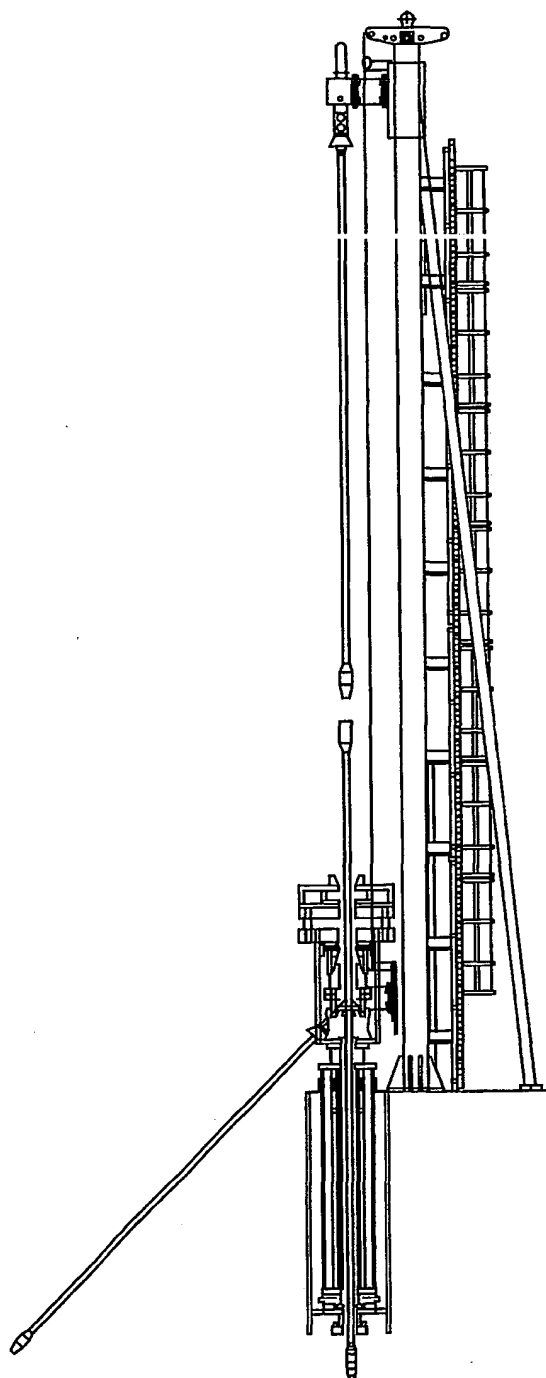


Fig. 15a

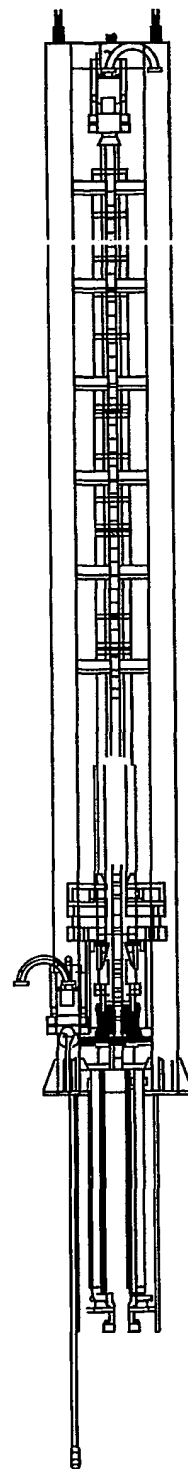


Fig. 15b

17 / 32

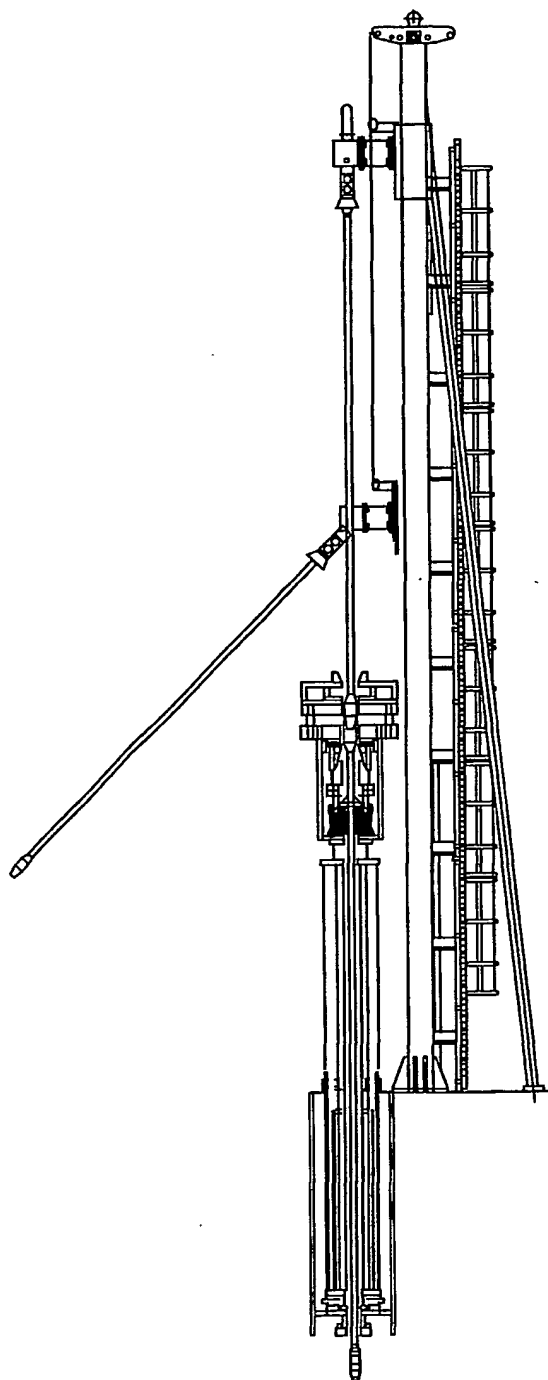


Fig. 16a

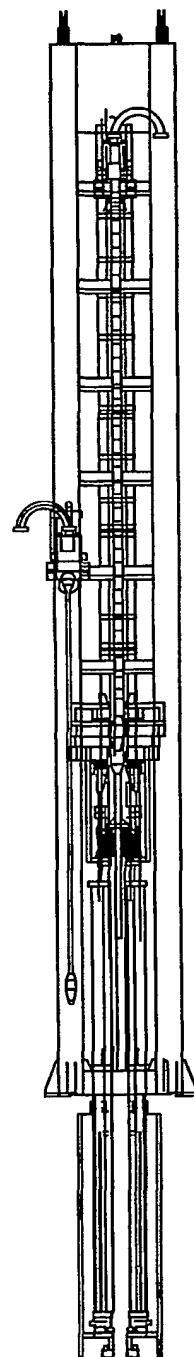


Fig. 16b

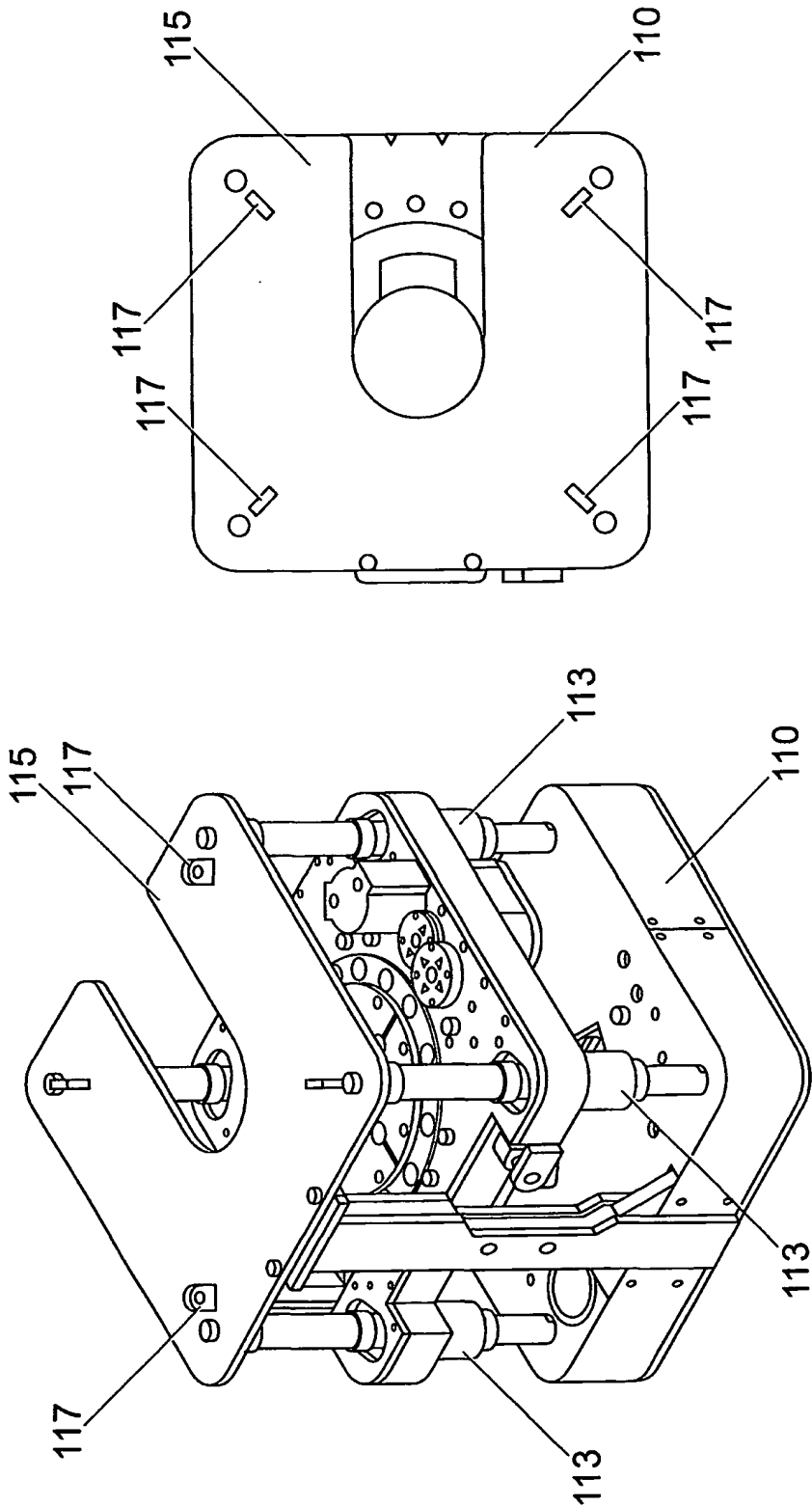


Fig. 17c

Fig. 17b

20 / 32

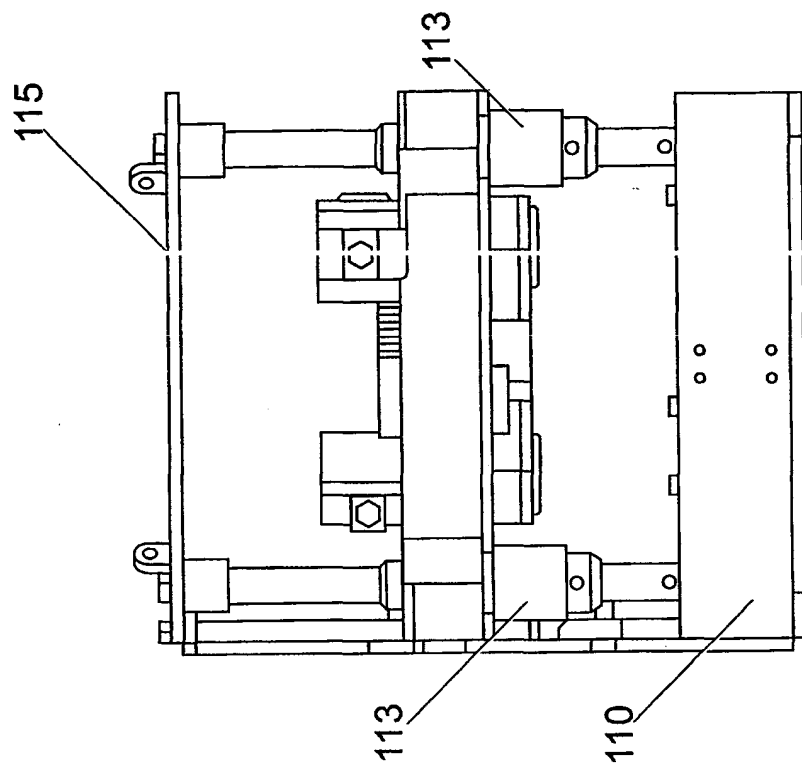


Fig. 17e

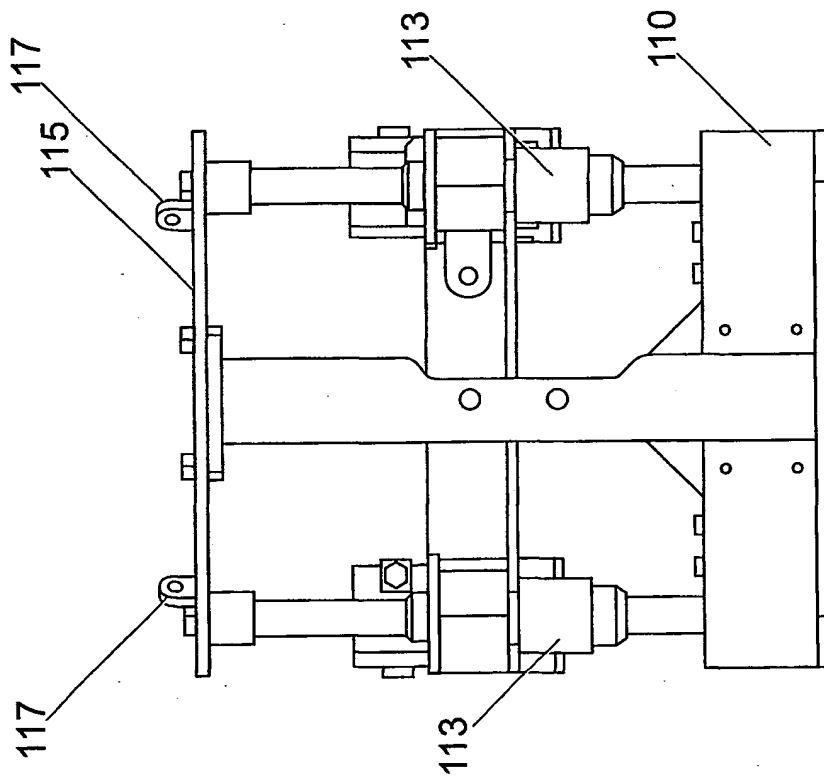
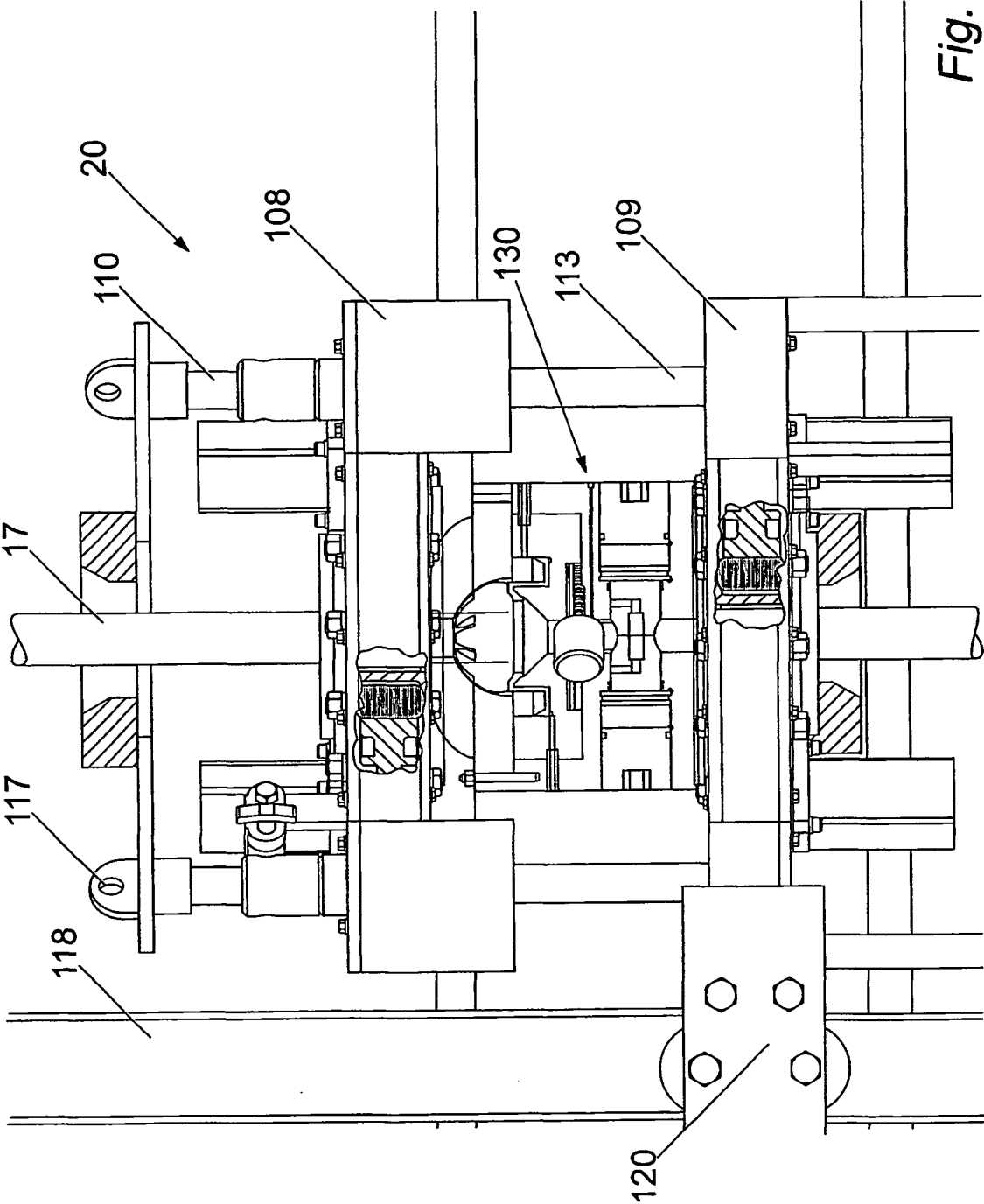


Fig. 17d



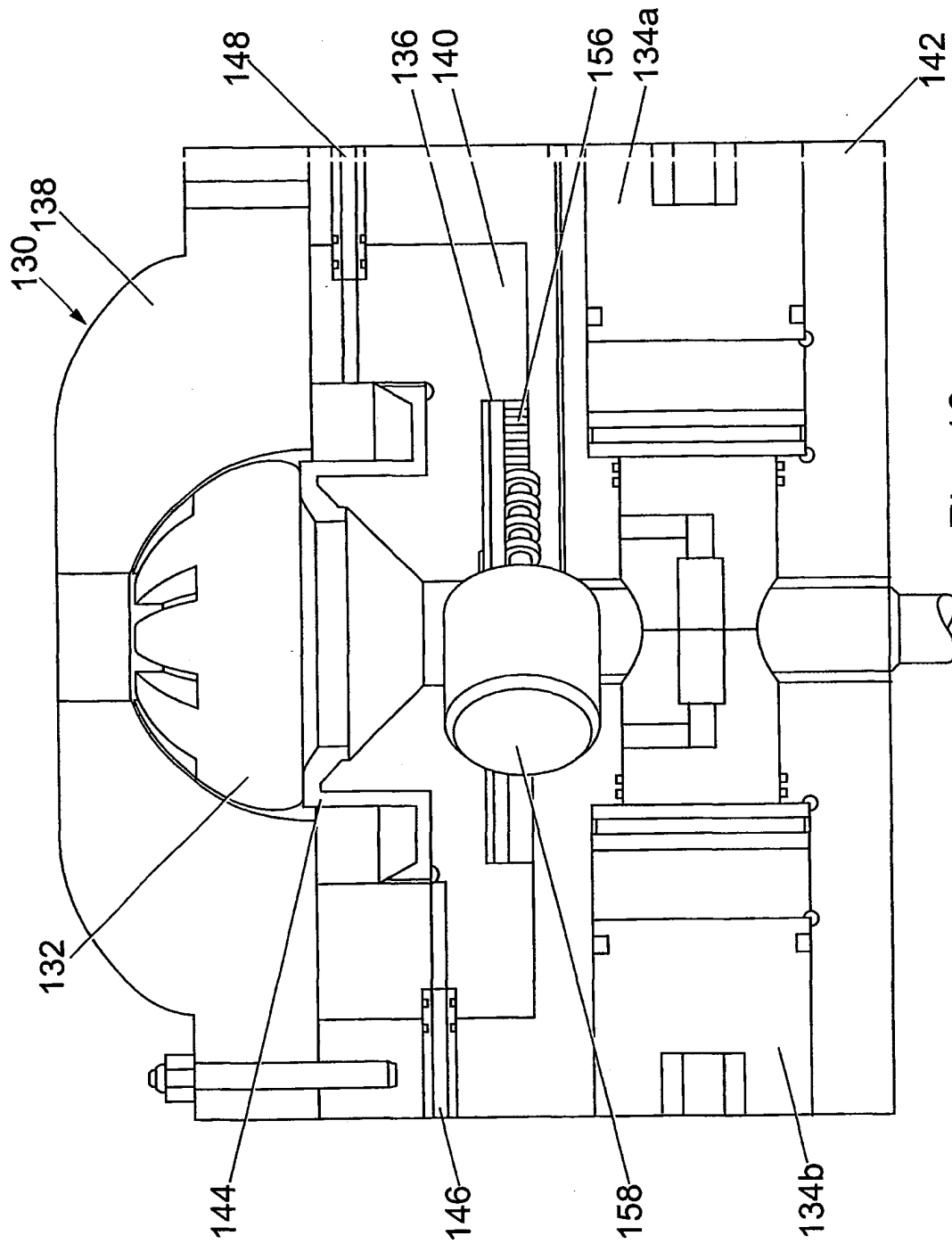


Fig. 19

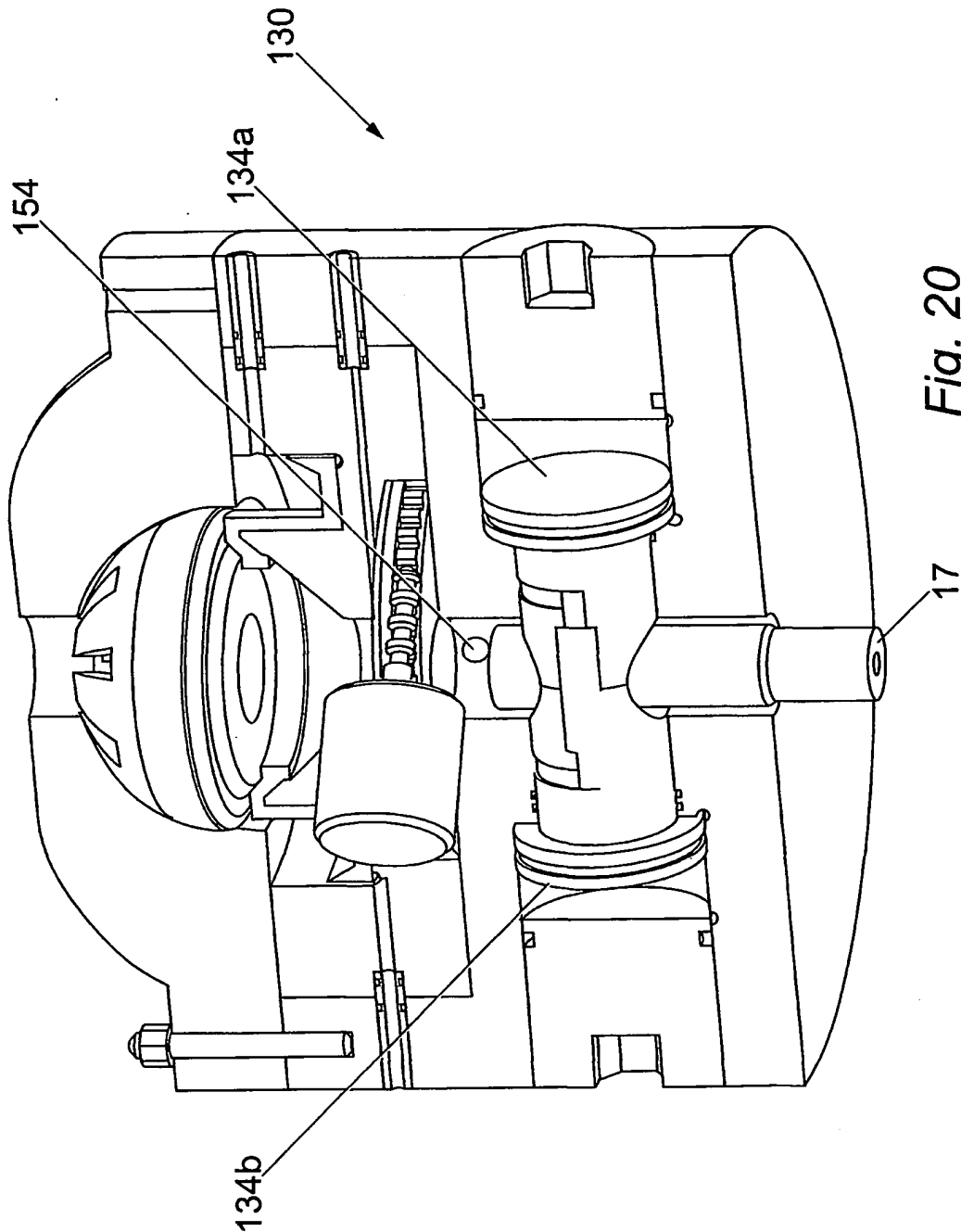


Fig. 20

24 / 32

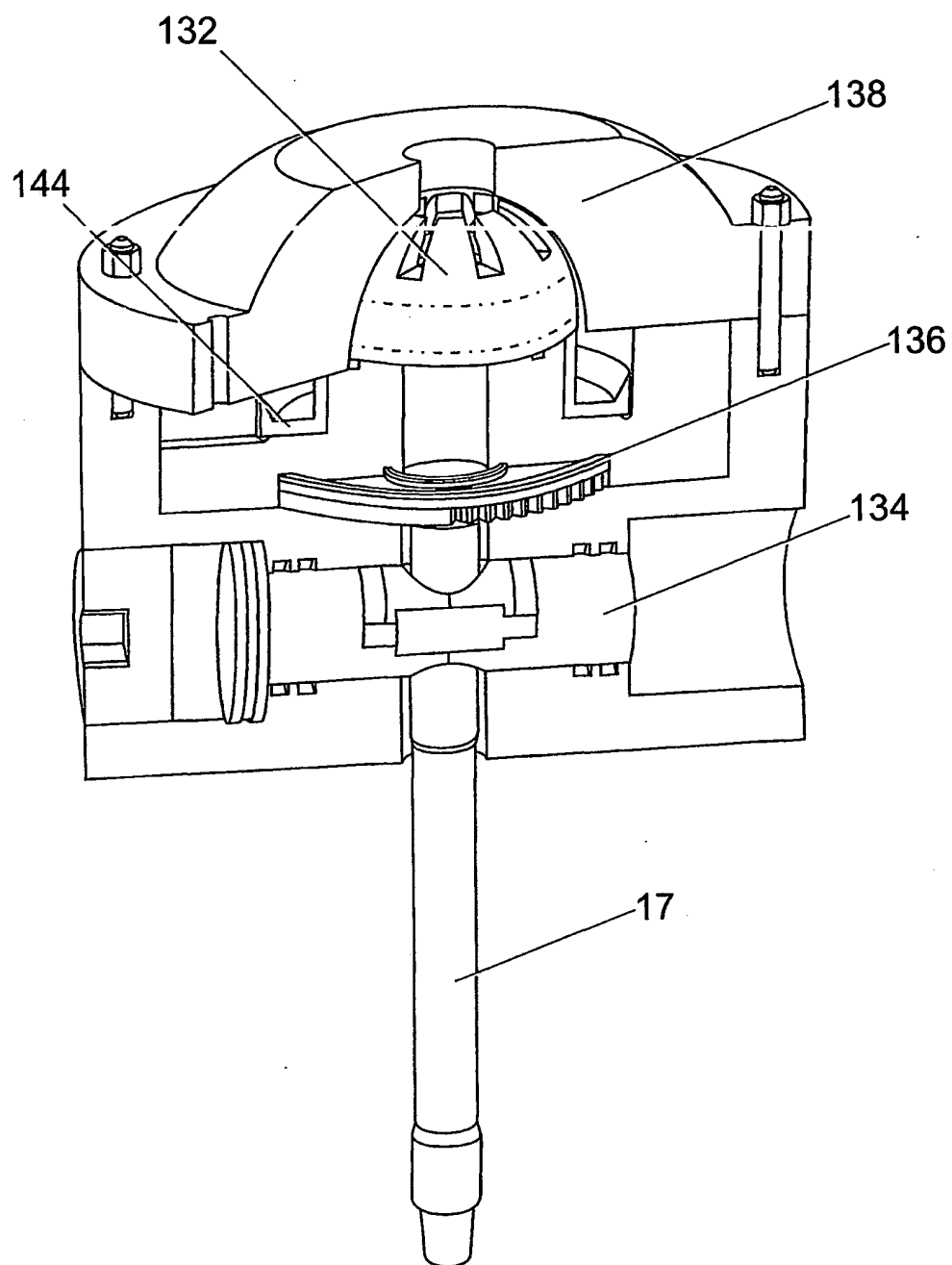


Fig. 21

25 / 32

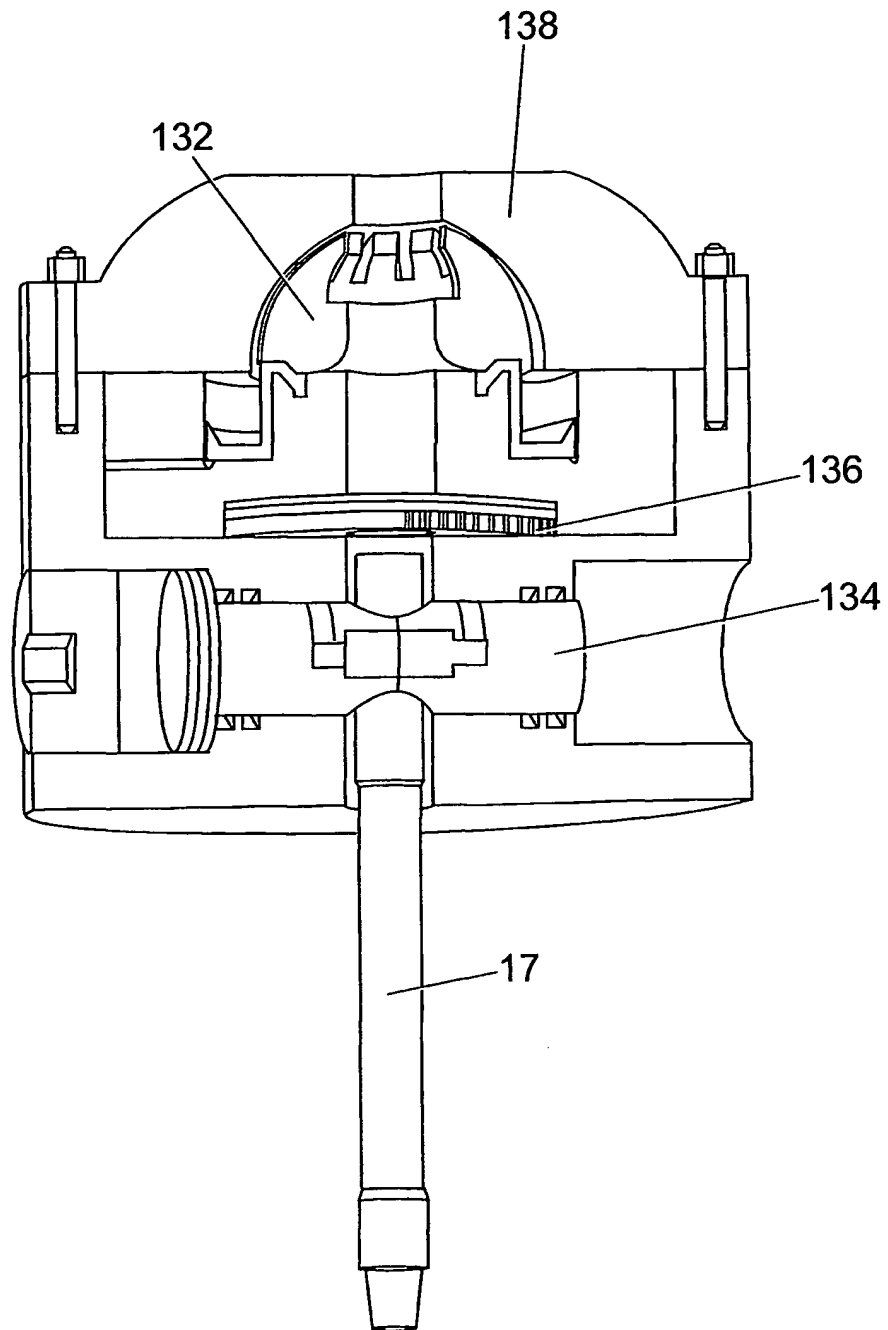


Fig. 22

26 / 32

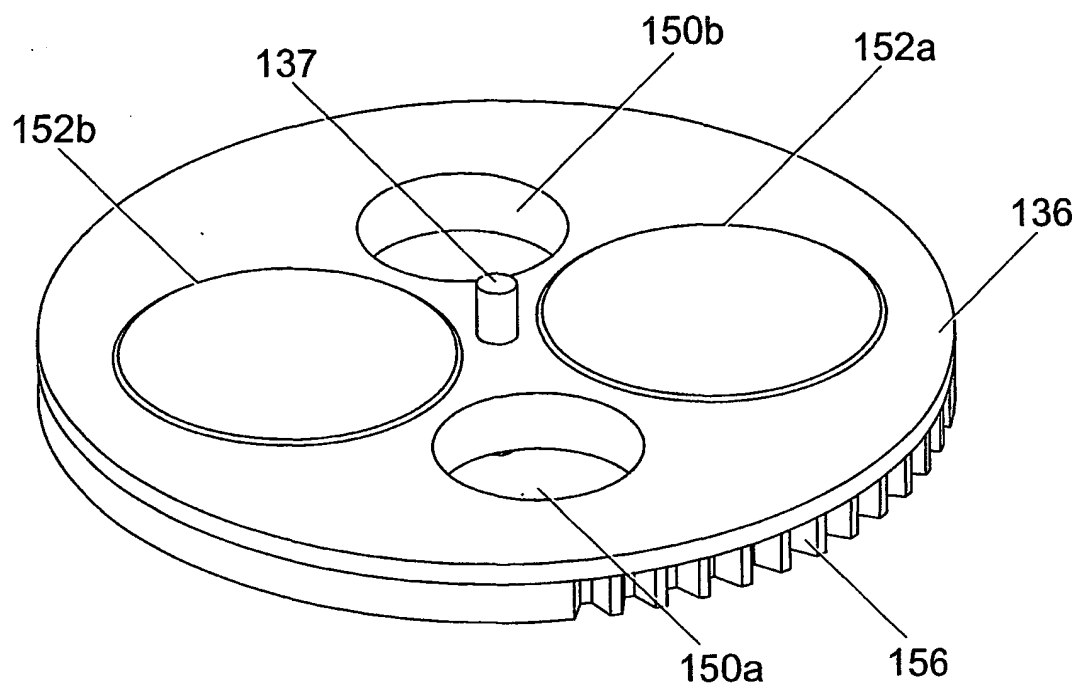
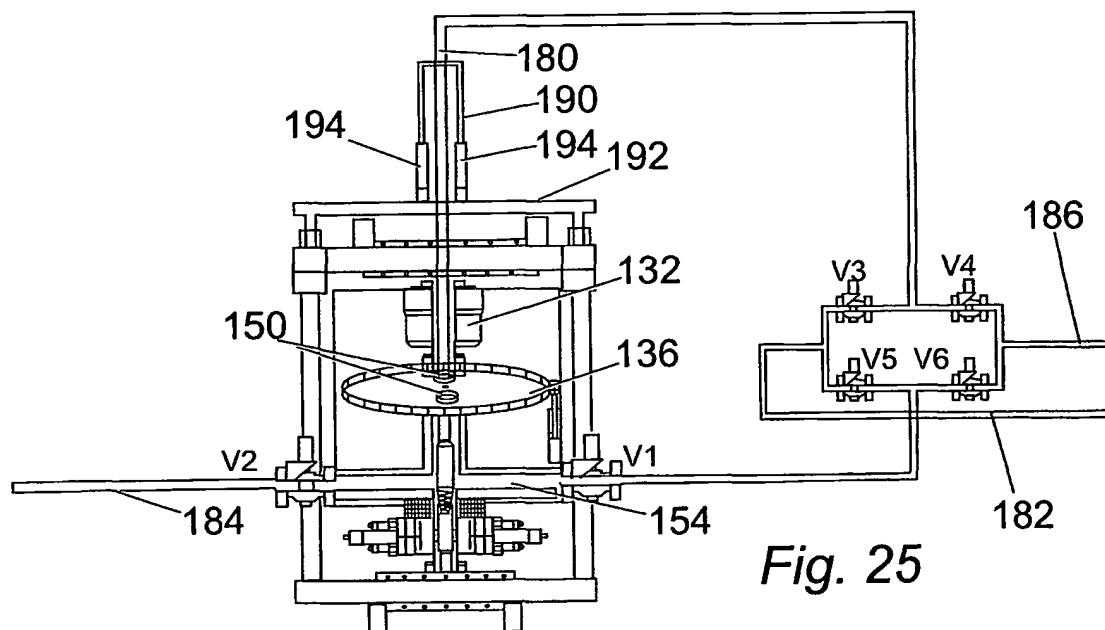
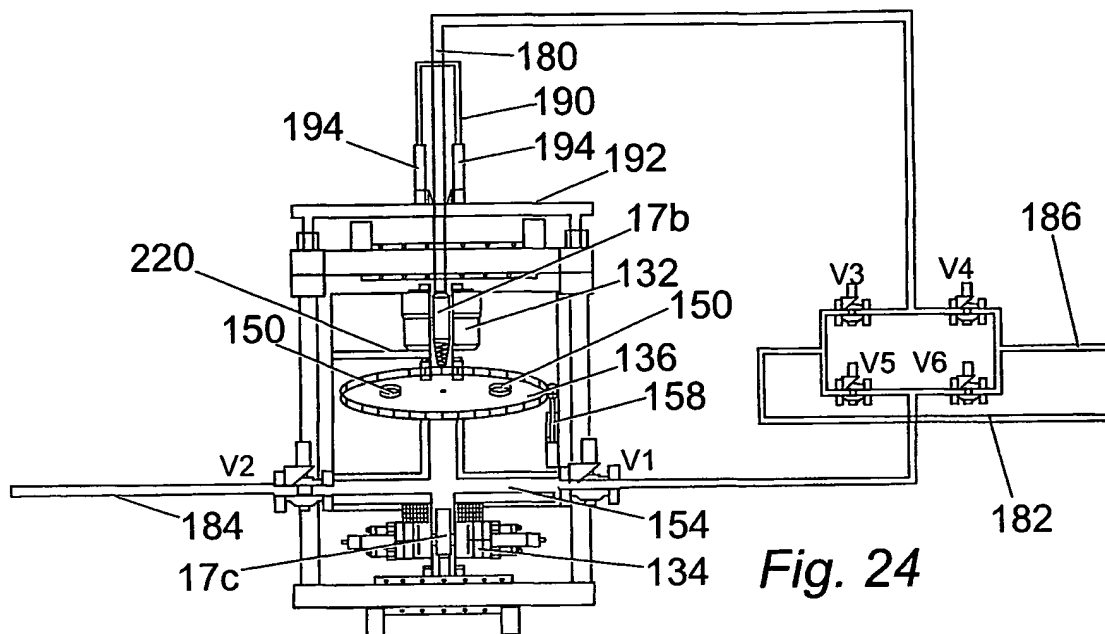


Fig. 23

27 / 32



28 / 32

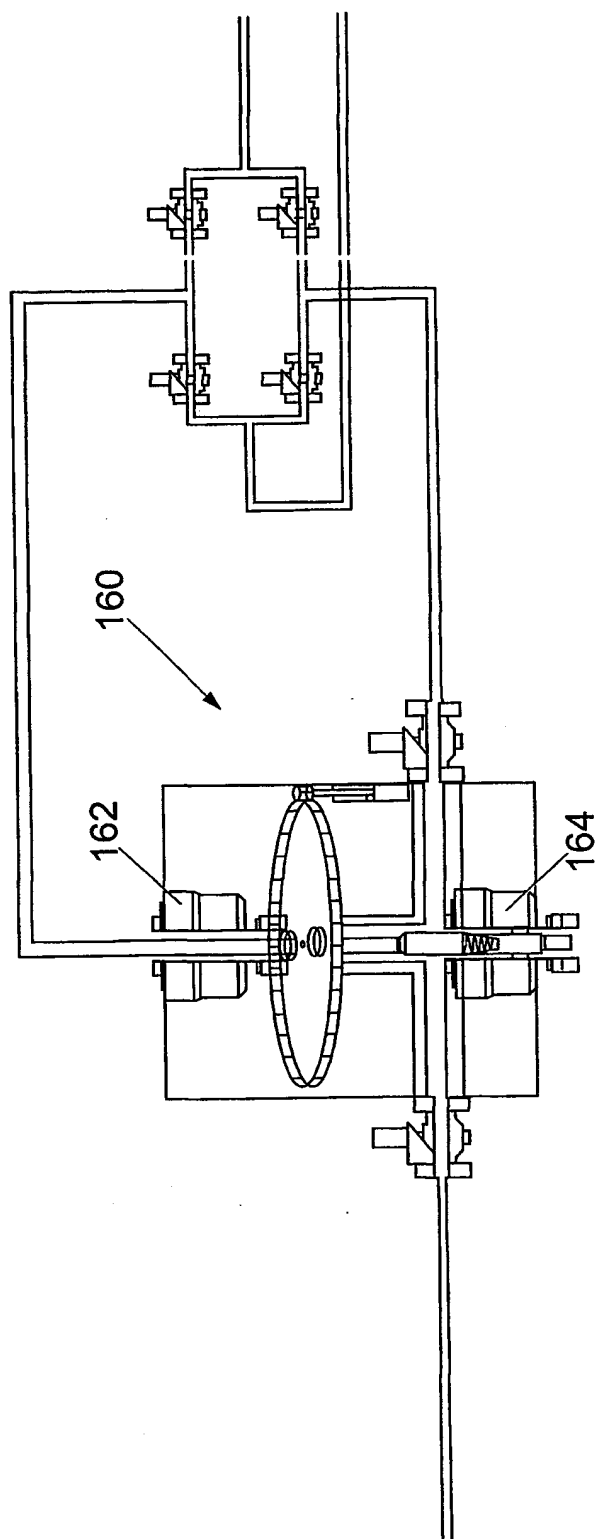


Fig. 26

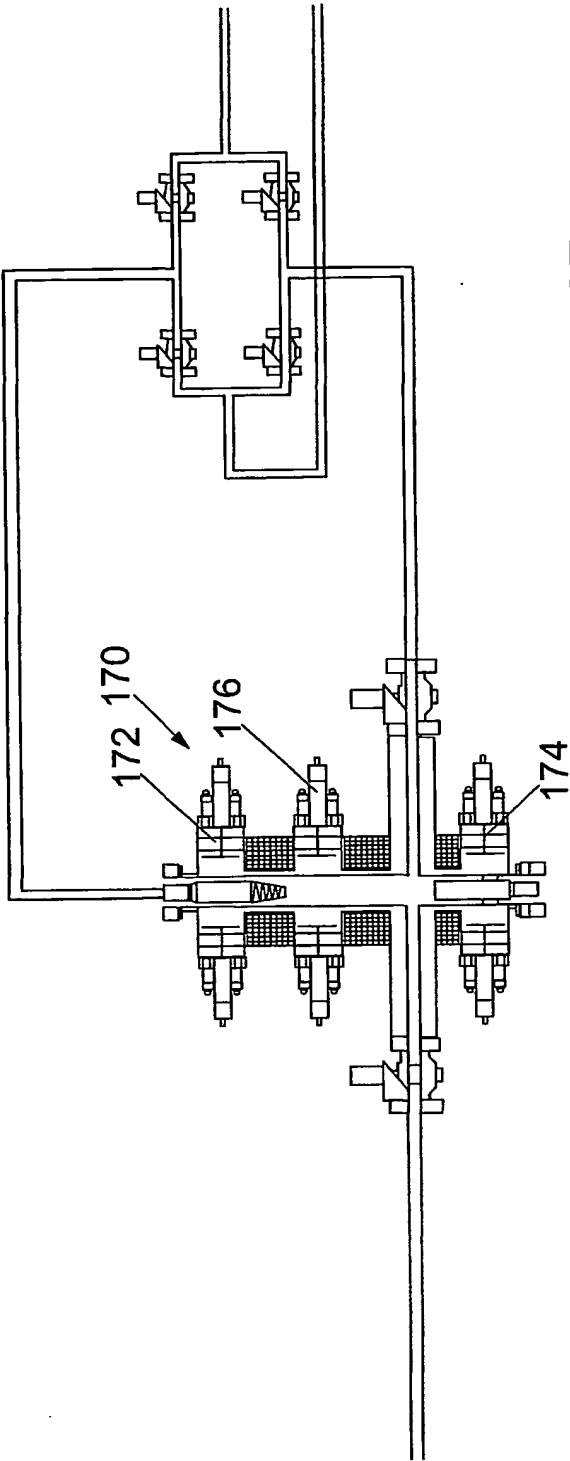
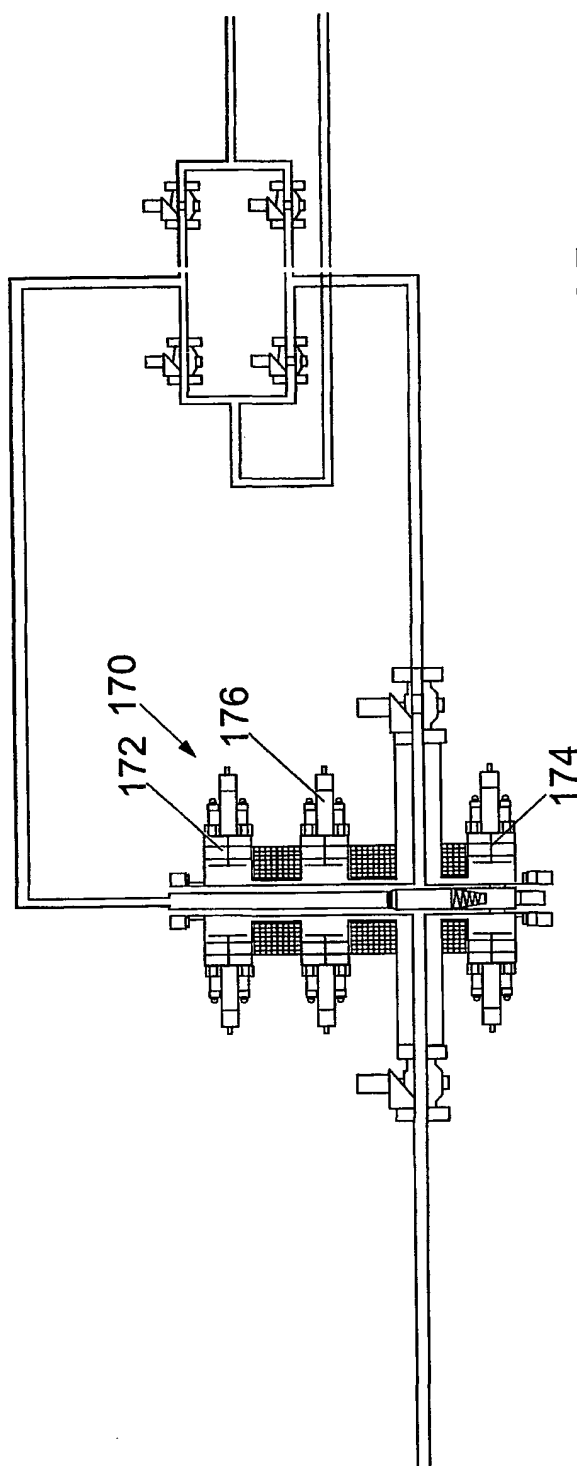
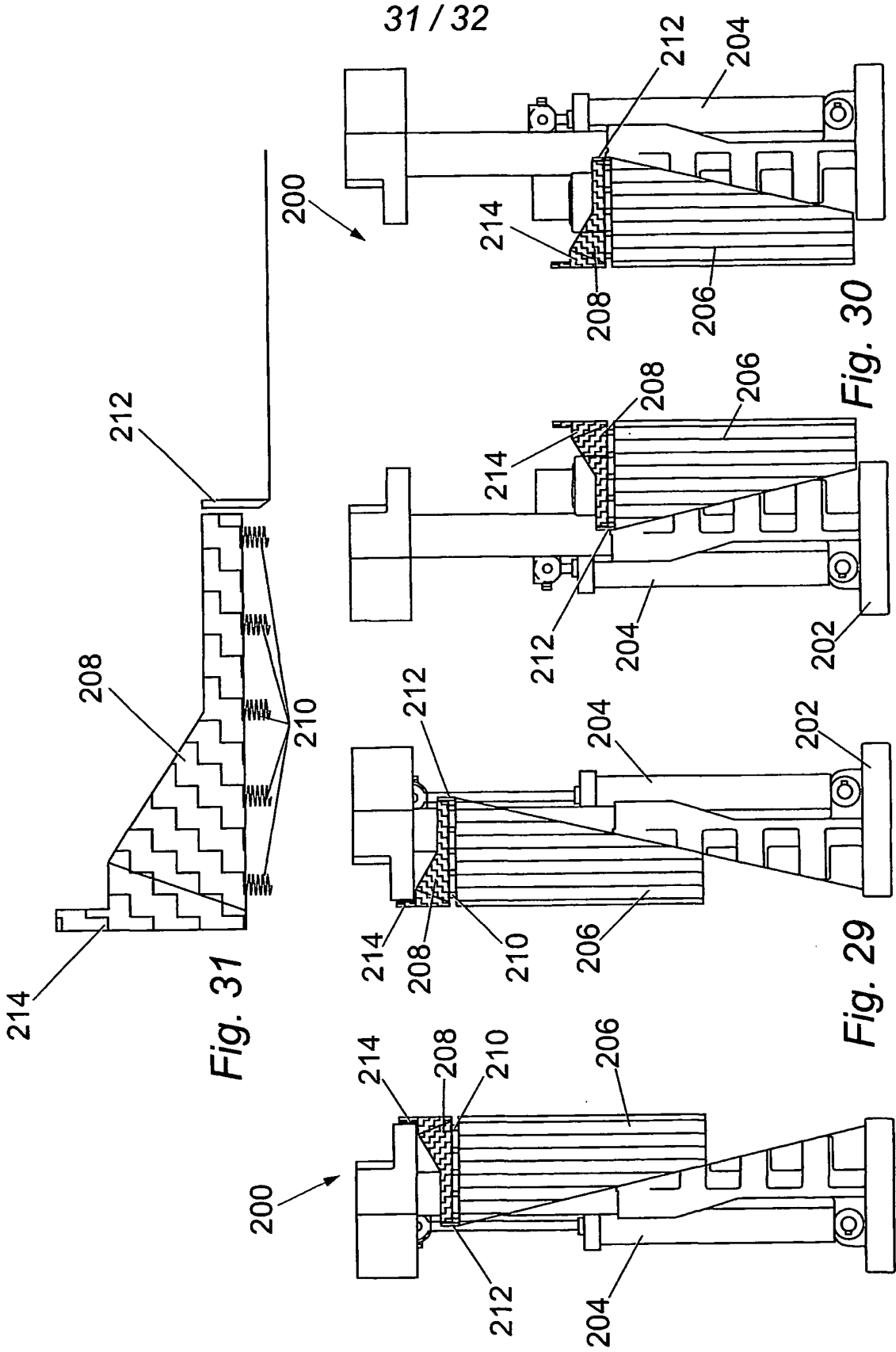


Fig. 27

30 / 32





32 / 32

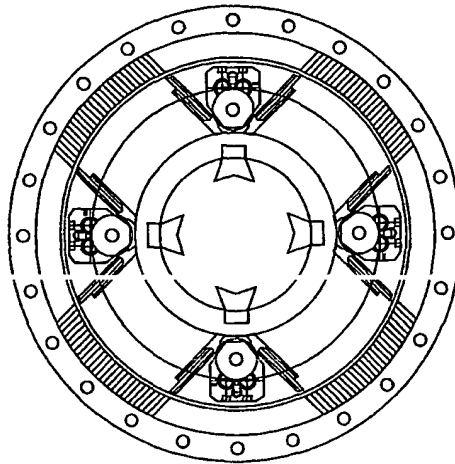


Fig. 34

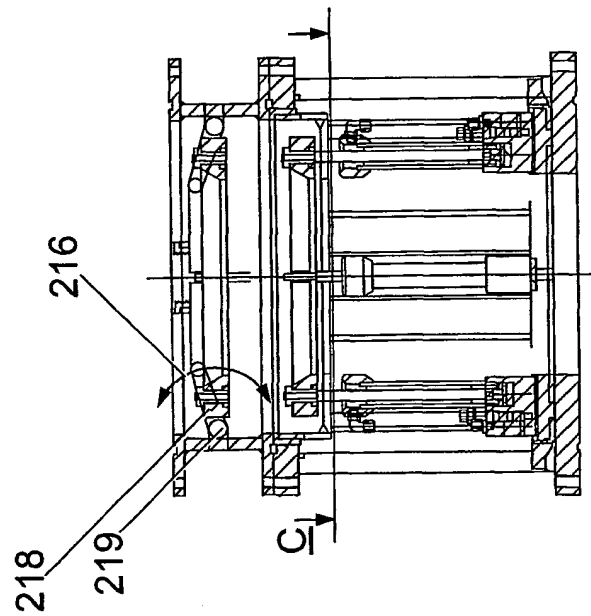


Fig. 33

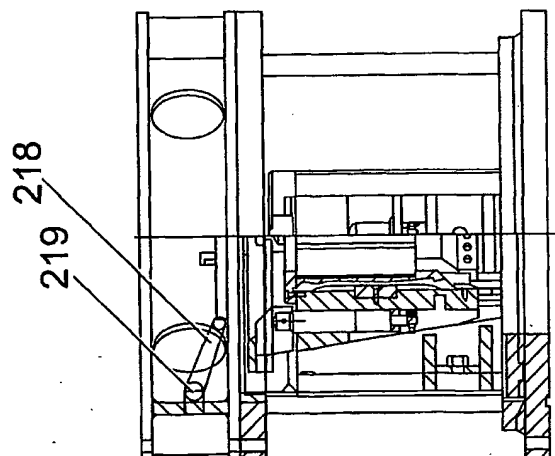


Fig. 32

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.

THIS PAGE BLANK (USPTO)